TIMBER SUPPLY BRANCH

TIMBER SUPPLY REVIEW

Invermere Timber Supply Area Analysis Report

October 2000

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Invermere Timber Supply Area Analysis Report

B.C. Ministry of Forests
595 Pandora Avenue
Victoria, B.C.
V8W 9C3

October 2000

Canadian Cataloguing in Publication Data

Main entry under title:
Invermere timber supply area analysis report

Includes bibliographical references: p.
ISBN 0-7726-4351-2

1. Timber – British Columbia – Invermere Region. 2. Forests and forestry – British Columbia – Invermere Region – Mensuration. 3. Forest management – British Columbia – Invermere Region. 4. Nelson Forest Region (B.C.). I. British Columbia. Ministry of Forests.

SD438.B7I56 2000 333.75'11'0971165 C00-960292-5

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Preface

This report contains a timber supply analysis and socio-economic analysis and is part of the provincial Timber Supply Review carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia. A review of each TSA and TFL is completed at least once every five years.

To determine allowable timber harvesting levels accurately and rationally, the Chief Forester must have an up-to-date assessment of the timber supply based on the best available information and reflecting current management direction. **The report that follows provides this assessment but should not be construed as a recommendation on permissible harvest levels.**

This report focuses on a single forest management scenario — current management practices. Current management practices are defined by the specifications in management plans for the TSA including guidelines for the protection of forest resources, the *Forest Practices Code* (FPC) and official land-use decisions made by Cabinet.

Assessing the implications of only current practices rather than looking at a number of different management regimes expedites the analysis process, allowing analysis of all TSAs in the province every five years. An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply provide a basis for discussions among stakeholders about alternative timber harvesting levels.

In addition to having an up-to-date assessment of timber supply when setting the allowable annual cut (AAC), the Chief Forester considers short- and long-term implications of alternative harvest levels, the capabilities and requirements of existing and proposed processing facilities, and the social and economic objectives of the Crown. The socio-economic analysis provides the Chief Forester with some of the additional information necessary for these considerations.

The socio-economic analysis considers forestry activity associated with the harvesting and processing of timber harvested from the TSA within the context of regional industry timber supply and production capacity.

This report is the third of five documents that will be released for each TSA as part of the Timber Supply Review. (The first two documents are the information report and the data package). This document provides detailed technical information on the results of the timber supply and socio-economic analyses. A fourth document called the public discussion paper will summarize the technical information to provide a focus for public discussions of possible timber harvest levels. The fifth will outline the Chief Forester's harvest level decision and the reasoning behind it.

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Invermere Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over the short (next 20 years), medium (21 to 80 years from the present) and long (beyond 80 years from the present) terms. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management practices. The purpose of the timber supply analysis is to assess the timber supply implications of current forest management, and of uncertainties about land base, growth and yield, and practices associated with current management. **The forecasts in this report should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The Invermere TSA is located in the southeastern portion of British Columbia primarily in the Englemann spruce-subalpine fir, Montane spruce and alpine tundra biogeoclimatic zones. It covers an area of approximately 1 111 000 hectares of which about 242 000 hectares are considered available for timber production and harvesting under current forest management practices. These practices follow the standards and legislation set out by the *Forest Practices Code*, various agreements and plans which guide current operational management. Within the area available for timber harvesting, most of the forests are dominated by lodgepole pine, although there are also significant areas dominated by Douglas-fir, yellow pine (ponderosa pine), balsam, spruce and larch.

The results of this timber supply analysis suggest that harvests can be maintained at the current AAC attributable to the Invermere TSA (581 570 cubic metres per year, adjusted to account for 9930 cubic metres attributable to woodlots) for only one decade. This level can be maintained without creating future timber supply disruptions, if followed by a controlled reduction over the subsequent three decades to 426 881 cubic metres per year, which can be sustained for the remainder of the 250-year analysis horizon. This result reflects current knowledge and information on forest inventory, growth, and management. However, it is important to recognize that uncertainty exists about several factors important in defining timber supply. A series of sensitivity analyses show that these uncertainties can affect timber supply to varying degrees.

Short-term timber supply is sensitive to changes that influence the amount of timber available from existing unmanaged stands, because the harvest forecast relies on these stands for the next 90 years. In particular, any reductions in estimates of timber volume in existing stands, or in the size of the timber harvesting land base could have negative effects on base case projected harvest levels over the short term (next 20 years). An audit conducted in 1997 showed that the inventory estimates of volume for mature stands (over 60 years old) on the physically and economically operable land base are not statistically different from volumes derived using ground measurements. The audit therefore suggests that the inventory reasonably portrays the standing timber volume in existing stands at the TSA level.

Medium-term timber supply is affected by estimates of forest cover requirements for management of ungulate winter range, and the rule used to set harvest priority, as well as the factors affecting short-term timber supply mentioned above.

Long-term timber supply is affected by uncertainties in the application of management requirements for landscape-level biodiversity, estimates of regenerated stand yields, estimates of site productivity for old-growth stands, and the availability of seeds from seed orchards, as well as the factors affecting medium-term timber supply mentioned above.

Improved local estimates of site productivity, seed quality and availability, and regenerated stand yields will be possible as new data is collected and used to develop new models. The requirements for landscape-level biodiversity will also be better defined over time; however, this analysis uses the best data and models presently available to forecast timber supply in British Columbia.

The socio-economic analysis for the Invermere TSA indicates that the current AAC (including the AAC allocated to woodlot licences) of 591 500 cubic metres could support approximately 703 person-years of direct employment and an estimated 774 person-years of indirect and induced employment across the province.

The base case harvest forecast for the next decade of 581 570 cubic metres per year, if fully harvested and utilized, would generate an estimated $18.9 million in provincial government revenues in the first decade. With the subsequent harvest forecast levels in the base case, the estimated revenue is projected as follows: $17.1 million in the second decade; $15.3 million in the third decade and $13.9 million in the fourth and subsequent decades.

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Introduction

Timber supply* is the quantity of timber available for harvest over time. Assessing the timber supply involves considering physical, biological, social and economic factors for all forest resource values, not just for timber harvesting. Physical factors include the land features of the area under study as well as the physical characteristics of living organisms, especially trees. Biological factors include the growth and development of living organisms. Economic factors include the financial viability of conducting forest operations, and the broader community and social aspects of managing the forest resource.

All of these factors are linked: the financial viability of harvest operations depends upon the terrain, as well as the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth patterns. Decisions about whether a stand is available for harvest often depend on how its harvest could affect other forest values, such as wildlife or recreation.

These factors are also subject to both uncertainty and different points of view. Financial viability may change as world timber markets change. Unforeseen losses due to fire or pest infestations may alter the amount and value of timber. The appropriate balance of timber and non-timber values in a forest is an ongoing subject of debate, and is complicated by changes in social values and objectives over time.

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management, as well as the uncertainties affecting these conditions, must first be understood. Timber supply analysis is the process of assessing and predicting the current and future timber supply for an area. For a timber supply area (TSA)*, the timber supply analysis forms part of the information used by the Chief Forester of British Columbia in determining an allowable annual cut (AAC)* — the permissible harvest level for the area.

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the *Forest Act* requires that the timber supply for management units throughout British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

**Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 7 *of the* Forest Act.

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

Timber supply analysis involves three main steps. The first is collecting and preparing information and data in which the B.C. Forest Service forest inventory* plays a major role. The second step is using this data along with a timber supply computer model or models* to make projections or estimates of possible harvest levels over time. These projections are made using different sets of assumed values or conditions for forest inventory and management factors. The third step is interpreting and reporting results.

The following sections outline the timber supply analysis for the Invermere TSA. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Timber supply analysis methods and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. Section 6 explores the timber supply implications of alternative forest management practices. This is followed by a summary and conclusions for the timber supply analysis in Section 7. Section 8 shows results of a socio-economic analysis for the Invermere TSA. Appendixes A and B contain further details about the data and assumptions used in the analysis.

As part of the timber supply review, information is gathered on the short- and long-term implications of alternative harvest levels, and the capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis provides information for the Chief Forester and the local community to better understand the potential magnitude of impacts associated with harvest level changes.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Invermere TSA within the context of regional timber supplies and production capacity. It does this by examining the profile of the region and the local forest industry, and by assessing employment and income implications of the timber harvesting levels projected in the base case.

The analysis includes estimates of the employment and income impacts associated with timber supply analysis projections by three main sectors: harvesting and other woodlands related, processing, and silviculture. Employment is measured in person-years*. Employment income is calculated using average industry income estimates.
Data on direct employment, harvest levels, and fibre flows was obtained by surveying licensees and mill operators. The information was used to estimate harvesting, processing and silviculture direct employment averages associated with the harvest and the proportion of workers living in the area. The estimates of local and provincial harvesting, processing, and silviculture direct employment were then used to determine ratios of employment per 1000 cubic metres of timber harvested.

Forest inventory
An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Model
An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

Person-year(s)
One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Introduction

Indirect and induced employment* figures were calculated using the Invermere TSA and provincial employment multipliers* developed by the Ministry of Finance and Corporate Relations. Indirect impacts result from direct businesses purchasing goods and services; induced impacts result from direct employees purchasing goods and services. Employment coefficients* per 1000 cubic metres were also determined for the indirect and induced impacts.

To estimate the level of employment that could be supported by alternative harvest rates, projected timber supply levels were multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current productivity, harvest practices and management assumptions* and will not likely reflect industry conditions decades into the future. As such, the employment estimates can only be viewed as general indicators.

Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.
Employment multiplier
An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Employment coefficient
The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.
Management assumptions
Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

1 Description of the Invermere Timber Supply Area

The Invermere Timber Supply Area (TSA) is situated in southeastern British Columbia and covers approximately 1.1 million hectares. Located in the eastern portion of the Nelson Forest Region, the boundaries of the Invermere TSA are similar to those of the Invermere Forest District, which also include Tree Farm Licence* 14, as well as several provincial parks (listed below). The TSA is administered from the forest district office located in Invermere.

Two national parks (Banff and Kootenay) border the TSA to the northeast and the following provincial parks are within the TSA: Mount Assiniboine, Height of the Rockies, Top of the World, Purcell Wilderness Conservancy, Bugaboo Glacier, Windermere Lake, Whiteswan Lake, Premier Lake, Canal Flats, James Chabot and Dry Gulch.

The major population centre in the TSA is the town of Invermere, which is home to about 30% of the TSA's population of 9,227 (1996 census). Windermere, Canal Flats and Edgewater are the other major centres, while smaller communities include Radium Hot Springs, Wilmer, Fairmont Hot Springs and Parson.

The Invermere TSA straddles two mountain ranges, the Purcell Mountains to the west and the Rocky Mountains to the east. In between lies the Rocky Mountain Trench, a broad, flat valley running north-south with numerous rivers and wetlands. The Columbia River flows north through the trench from Columbia Lake, creating the Columbia Wetlands, a significant wetland ecosystem that bisects the TSA. The Kootenay River enters the trench just south of Columbia Lake and flows south through the TSA.

Forests in the Invermere TSA have medium to low productivity relative to the rest of B.C. The dominant species in the TSA are lodgepole pine, Douglas-fir, spruce, and subalpine fir (balsam). The current allowable annual cut (AAC) for the Invermere TSA is 591 500 cubic metres. This level was set in 1996, down 10% from the previous AAC determination. Since 1996, woodlot licences with a total AAC of 9930 cubic metres have been issued. Woodlot licences are administered separately from the TSA, thus the harvest level currently attributable to the TSA, and that is used for this report, is 581 570 cubic metres. In this timber supply analysis, about 44% of the TSA (488 000 hectares) is classified as Crown forest land managed by the B.C. Forest Service. Approximately 50% of that Crown forest (241 759 hectares or 22% of the total TSA land base) is considered available for harvesting under current management practices.

Significant changes that influence forest management in the Invermere TSA have occurred since the last timber supply review was completed. These changes include:

- implementation of the *Forest Practices Code**;
- establishment of landscape units* and biodiversity* emphasis options (pending formal designation);
- designation of scenic corridors.

Tree farm licence (TFL)
Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.
Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

1 Description of the Invermere Timber Supply Area

As well, in 1997 the provincial government approved the *Kootenay-Boundary Land Use Plan Implementation Strategy*. The strategy provides an expression of the government's commitment to achieve the Crown's social and economic objectives for the region, including the Invermere TSA. More recently on June 29, 2000, government released the *Kootenay-Boundary Higher Level Plan Order – Draft*. The announcement detailed government's intent to establish a higher level plan under the *Forest Practices Code* to declare forestry-related components of the *Kootenay-Boundary Land Use Plan Implementation Strategy* as legal requirements. Following the public review period, the plan will be revised as appropriate before final approval by the ministers of Environment, Lands and Parks, of Forests, and of Energy and Mines, who will first consider public comments on the draft *Higher Level Plan (HLP) Order*.

Recreational use of the forests in the Invermere TSA is high due to the proximity of provincial and national parks and the exceptional natural scenery. The lakes, rivers and mountainous terrain of the area provide a wide range of front- and back-country recreational opportunities including mountain-biking, hiking, climbing, fishing, camping, wildlife viewing, whitewater boating, heli-skiing, snowmobiling, ski mountaineering, and cross-country as well as downhill skiing.

The Invermere TSA also contains abundant water resources, approximately 18% of which are within watersheds* that are licensed for domestic use.

Watershed
An area drained by a stream or river. A large watershed may contain several smaller watersheds.

1 Description of the Invermere Timber Supply Area

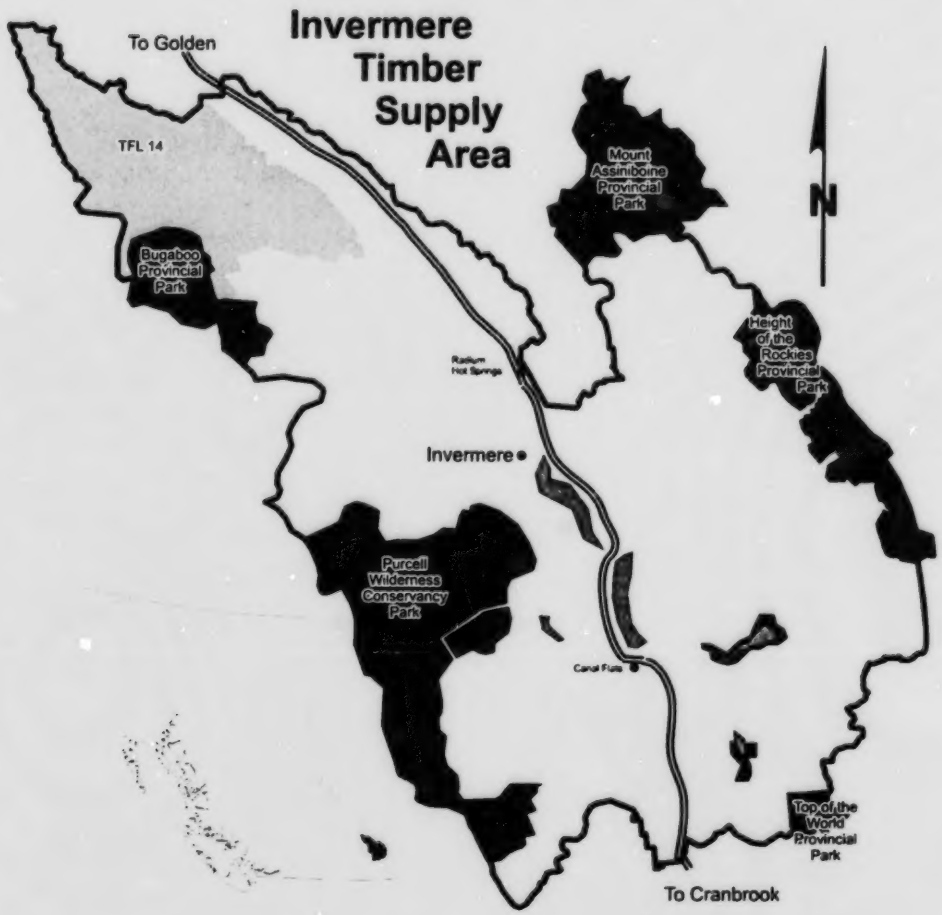


Figure 1. Map of the Invermere Forest District, Nelson Forest Region.

1 Description of the Invermere Timber Supply Area

1.1 The environment

The Invermere TSA is located in the interior dry-belt of the province and includes six biogeoclimatic zones*. These ecosystem units reflect distinct differences in terrain, climate and the species of trees that are present.

The Ponderosa Pine zone (PP) occurs in the very dry southern end of the trench as a thin band in the bottom of the trench and on lower slopes of adjacent valleys. The PP zone is the driest and the warmest forested zone in summer in B.C. Summers are hot and dry, resulting in large moisture deficits during the growing season. Winters are cool with light snow cover. Forests of the PP zone are open and park-like, dominated by yellow pine and Douglas-fir. Aspen, birch and cottonwood are also found on moist sites and along floodplains. The PP zone has an extensive fire, domestic grazing and logging history.

The Interior Douglas-fir (IDF) zone occurs in valley bottoms and along the lower slopes of the Rocky Mountain Trench, generally above the PP zone (where it occurs) and below the Montane Spruce zone. The IDF has warm, dry summers, a fairly long growing season and cool winters. Moisture is the limiting factor for tree growth and substantial growing season moisture deficits are common. Forests are dominated by Douglas-fir, western larch and ponderosa pine, but lodgepole pine, trembling aspen, hybrid white spruce, ponderosa pine and paper birch also occur. As a result of soil, topography and wildfire history, grassland communities and transitional woodland have developed in some areas, particularly from Canal Flats to Invermere.

The Montane Spruce (MS) zone occurs at middle elevations, generally above the IDF zone. It is characterized by cold winters and moderately short, warm summers. The growing season is sufficiently warm and dry that moisture deficits can occur. Forests in the MS zone are dominated by hybrid white spruce and subalpine fir. Lodgepole pine stands are also common as a result of extensive fire history.

The Interior Cedar Hemlock (ICH) zone occurs in small pockets at lower to middle elevations in the Rocky Mountain Trench near the Spillimacheen River and in the Parson area. This zone is characterized by warm dry summers and cool wet winters, and has the highest diversity of tree species of any zone in the province. The most common species are western redcedar, western hemlock, hybrid white spruce, subalpine fir, Douglas-fir, lodgepole pine and western larch. White pine, aspen, birch and cottonwood also occur.

The Engelmann Spruce-Subalpine Fir (ESSF) zone lies above the MS or ICH zones, and is the uppermost forested zone in most of B.C. The ESSF has a relatively cold, moist and snowy climate. Growing seasons are short and cool while winters are long and cold. Engelmann spruce, subalpine fir and lodgepole pine are the dominant trees, but Douglas-fir, western larch and white pine also occur.

The Alpine Tundra (AT) zone lies at high elevations, above the ESSF. The harsh alpine climate of this zone is cold, windy and snowy, and is characterized by low growing season temperatures and a very short frost-free period. The alpine zone is, by definition, treeless but tree species are common at lower elevations of the zone, usually in stunted form. Alpine vegetation is dominated by shrubs, herbs, mosses and lichens, although much of the landscape lacks vegetation and is the domain of rock, ice and snow.

The Invermere TSA is situated in the East Kootenay region of B.C., which supports the greatest diversity of wild ungulates and large predators in North America. Ungulate species include Rocky Mountain elk, Rocky Mountain bighorn sheep, white-tailed deer, mule deer, moose, caribou and mountain goats. Other large mammals include mountain lions, wolves, coyotes, black bears and grizzly bears. Small furbearers include beaver, mink, muskrat, otter, fisher, marten, skunk, weasel, badger, wolverine, bobcat, lynx, squirrel, fox and raccoon. Two uncommon reptiles are also found in this TSA, the western skink and the northern alligator lizard.

This region also supports 70% of the bird species known to occur in B.C. and 62% of all bird species that breed in the province. Wetlands along the rivers and lakes of the Invermere TSA are important habitat for nesting and migration. A wide variety of fish species inhabit the lakes and streams of the TSA, including bull trout (Dolly Varden), cutthroat trout, rainbow trout, eastern brook trout, kokanee, mountain whitefish, burbot, walleye and smallmouth bass.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.

1 Description of the Invermere Timber Supply Area

Species that are considered at risk or regionally significant and that occur or potentially may be found in the Invermere TSA are presented in Table 1.

Table 1. Vulnerable, endangered and threatened species

Endangered or threatened (red-listed)	Vulnerable (blue-listed)	
Northern leopard frog	bull trout	flammulated owl
Swainson's hawk	chiselmouth	short-eared owl
prairie falcon	painted turtle	white-throated swift
least chipmunk (ssp. *selkirki)*	rubber boa	Lewis's woodpecker
badger	American bittern	Bobolink
caribou, southern population	great blue heron	northern long-eared myotis
	sharp-tailed grouse (ssp. *Columbianus)*	grizzly bear
		fisher
	sandhill crane	wolverine (ssp. *luscus)*
	long-billed curlew	Rocky Mtn. bighorn sheep

Source: B.C. Conservation Data Centre, June 2000.

With regard to biodiversity requirements, forests within the Invermere TSA are comprised of a mix of immature, mature and old-growth forests. Old growth is becoming more dispersed and less extensive at lower elevations. Also, riparian habitats* and elk winter ranges are of particular importance to biodiversity in this TSA. Current forest management practices follow the legislation and guidelines set out by the *Forest Practices Code*. Consequently, the protection of wildlife and the environment are managed in part through the *Code*.

1.2 First Nations

There are two First Nations communities in the Invermere TSA, the Columbia Lake Band (at Windermere) and Shuswap Band (at Invermere), with a total population of over 400. The Shuswap Band is culturally and linguistically aligned with the Shuswap Nation, and politically aligned with the Ktunaxa Kinbasket Tribal Council.

The Invermere TSA lies within the traditional territory of the Ktunaxa Nation. The Ktunaxa Kinbasket Tribal Council, on behalf of the Ktunaxa Nation and the Shuswap Indian Band has submitted to the provincial government a comprehensive land claim covering the southeastern portion of the province, including the Invermere TSA. The Ktunaxa Nation has submitted an *Interim Measures Proposal* that encompasses the guide and outfitting tenure areas and the trap line areas registered to Columbia Lake Band members.

An Archaeological Overview Assessment (AOA) for the Invermere TSA was completed in March 1996. More intensive Archaeological Potential Mapping at the landscape-unit level is currently being conducted throughout the Invermere TSA. This mapping has been completed in 18 of the 38 landscape units and the remaining units are expected to be complete in the next several years. The archaeological overview assessment and mapping are the basis for locating areas and sites that may require further assessment in the form of Archaeological Impact Assessments (AIAs). The Invermere Forest District office is tracking archaeological impact assessment results and, at this time, a minimal amount of the timber harvesting land base* has been impacted.

Riparian habitat
The stream bank and flood plain area adjacent to streams or water bodies.

Timber harvesting land base
Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.

2 Information Preparation for the Timber Supply Analysis

Information required for timber supply analysis can be divided into three general categories: land base inventory; timber growth and yield; and management practices.

2.1 Land base inventory

The various sources of land base information used in this analysis were compiled into one computer file in 1999 by the Ministry of Forests, Invermere Forest District. This file contains information on the forest land in the Invermere TSA including general geographic location, area, nature of forest cover (such as number and type of trees, age, and timber volume), and other characteristics such as environmental sensitivity and physical accessibility (operability*). Stand attributes such as tree height, stocking* and age have been projected to 1998. The inventory file has been updated to account for timber harvesting up to the beginning of 1998 for the Invermere TSA.

The inventory file represents the land base for the entire TSA. It includes information on land that does not contain forest, and other areas where timber harvesting is not expected to occur. Examples are land set aside for parks, areas needed to protect wildlife habitat, areas in utility and transportation corridors, and residential and industrial development. A general description of these areas in the Invermere TSA is provided below. These types of areas do not contribute to the timber harvesting land base of the Invermere TSA. Before assessing timber supply, these non-contributing areas are identified and separated from the timber harvesting land base.

Identifying areas as not contributing to timber supply does not mean the area is removed from the TSA. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described herein is consistent with this philosophy.

This section describes the types of areas that do not contribute to the timber harvesting land base. Use of the term timber harvesting land base in this report does not mean the area is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value, and sites of adequate environmental resilience, to accommodate timber harvesting with due care for other resources.

For the Invermere TSA, the following types of areas were excluded from the timber harvesting land base.

- not managed by the B.C. Forest Service — these are non-Crown areas (such as private land and Federal reserves) and parks which are removed from the TSA. The forested portions of parks and ecological reserves contribute towards biodiversity values.
- non-forest areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- woodlot licences (WL)* — AACs and management in woodlot licences are administered separately from the rest of the TSA. WL areas are therefore excluded from the TSA timber harvesting land base.
- inoperable areas* — areas classified as unavailable for harvest for terrain-related or economic reasons. Characteristics used to define operability include slope, topography (e.g., presence of gullies or exposed rock), difficulty of road access, soil stability and elevation.

Operability
Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Stocking
The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.

Woodlot licence
An agreement entered into under the Forest Act. *It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.*
Inoperable areas
Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.

- environmentally sensitive areas* — portions of the areas considered environmentally sensitive and/or significantly valuable for other resources.
- sites with low timber productivity — areas occupied by forest with low timber-growing potential.
- deciduous*-leading stands — broadleafed deciduous species are generally not harvested in this TSA.
- problem forest types — stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability.
- riparian area* — areas assumed to be unavailable for harvesting to provide protection for riparian and stream ecosystems.
- existing unclassified roads, trails and landings — areas of forest land that have been removed from timber production due to access development and harvesting to date.

A more detailed description of these categories, including specific criteria for removal is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 2 summarizes the areas removed in each category, and shows the area of the timber harvesting land base.

Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.

Deciduous
Deciduous trees commonly have broad-leaves and usually shed their leaves annually.
Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

2 Information Preparation for the Timber Supply Analysis

Table 2. Timber harvesting land base for the Invermere TSA

Land classification	Area (hectares)	Per cent of total area (% area)	Per cent of productive forest (% area)
Total TSA area	1 110 689		
Private, Federal, parks and reserves	280 088	25.2	
Non-productive and non-forested	342 604	30.8	
Productive forest (PF)	487 998	44.0	100.00
Reductions to productive forest:			
Non-commercial cover	117	0.0	0.02
Inoperable	176 629	15.9	36.2
Environmentally sensitive areas (ESA)	30 243	2.7	6.2
Steep slopes	11 962	1.1	2.5
Riparian areas	5 207	0.5	1.1
Sites with low timber growing potential	6 416	0.6	1.3
Broadleafed deciduous types	4 251	0.4	0.9
Problem forest types (PFT)	4 686	0.4	1.0
Existing roads, trails, and landings (RTL)	6 728	0.6	1.4
Total reductions	246 239	22.2	50.4
Current timber harvesting land base (includes 18 178 hectares of not satisfactorily restocked* (NSR) land)	241 759	21.8	49.5
Reduction for future roads	2 650	0.2	0.5
Future timber harvesting land base	239 109	21.5	49.0

The current timber harvesting land base in the Invermere TSA represents about 22% of the total TSA area and about 50% of the forest area managed by the B.C. Forest Service (Crown forest). The categories which most reduce the availability of the Crown forest for timber supply are: inoperability (36.2%) and ESA's (6.2%). The remaining deducted categories, such as steep slopes, riparian areas, etc. represent 8.2% of the Crown forest. Because there is a high degree of overlap among land classification categories, the order in which the reductions are made dictates the area value portrayed in this table. For instance, riparian areas would constitute a larger proportion of the reduction if they were considered prior to inoperable areas.

The total TSA area has increased significantly since the last timber supply review, mainly through the inclusion of provincial parks including the Purcell Wilderness Conservancy and Top of the World. The current timber harvesting land base is approximately 8000 hectares (3.4%) larger than in the last timber supply review. This is mostly due to the reduced exclusions for forest ecosystem networks (FENs), problem forest types and steep slopes.

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

2 Information Preparation for the Timber Supply Analysis

Figure 2 represents both the total Invermere TSA area, and the Crown forested land base. About 56% of the total land base is classified as either not managed by B.C. Forest Service or non-forest. The Crown forested chart details the categories of forest land and shows that about 50% of the Crown forest land in the Invermere TSA is considered to be unavailable for harvesting. The main reasons for unavailability are physical or economic inoperability and environmental sensitivity. Approximately 50% of the productive forest is considered available for timber harvesting (including NSR and timber licences which have already been harvested and reverted to Crown ownership).

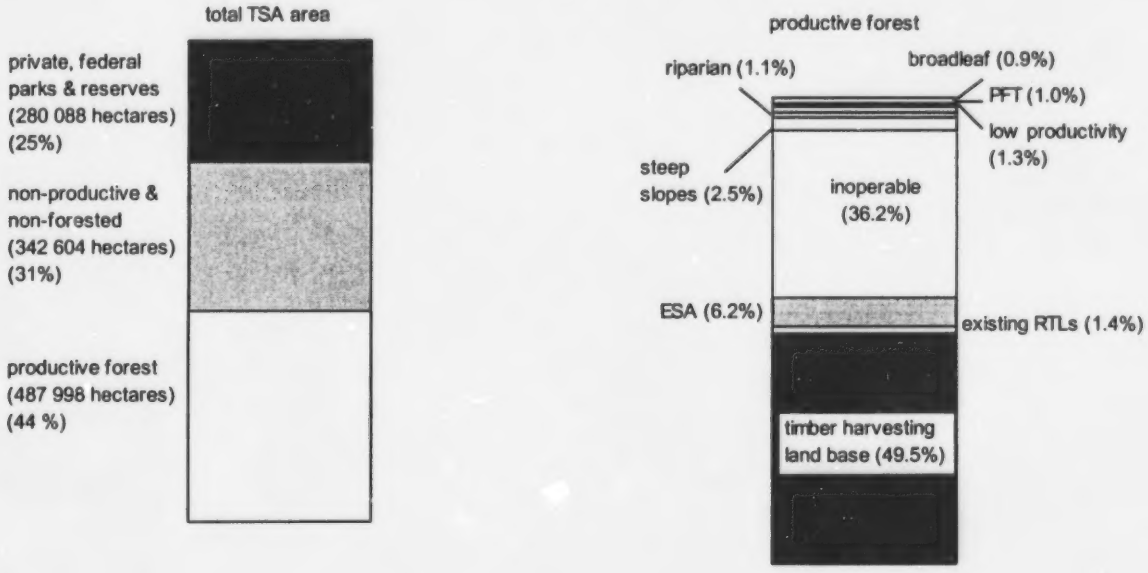


Figure 2. Composition of the total and Crown forested land bases — Invermere TSA, 2000.

Figure 3 shows overall distribution of biogeoclimatic (BEC) subzones in the Crown forested area in the Invermere TSA. For example, the ESSFdk variant makes up 68% of the Crown forested area, only 25% of which is within the timber harvesting land base.

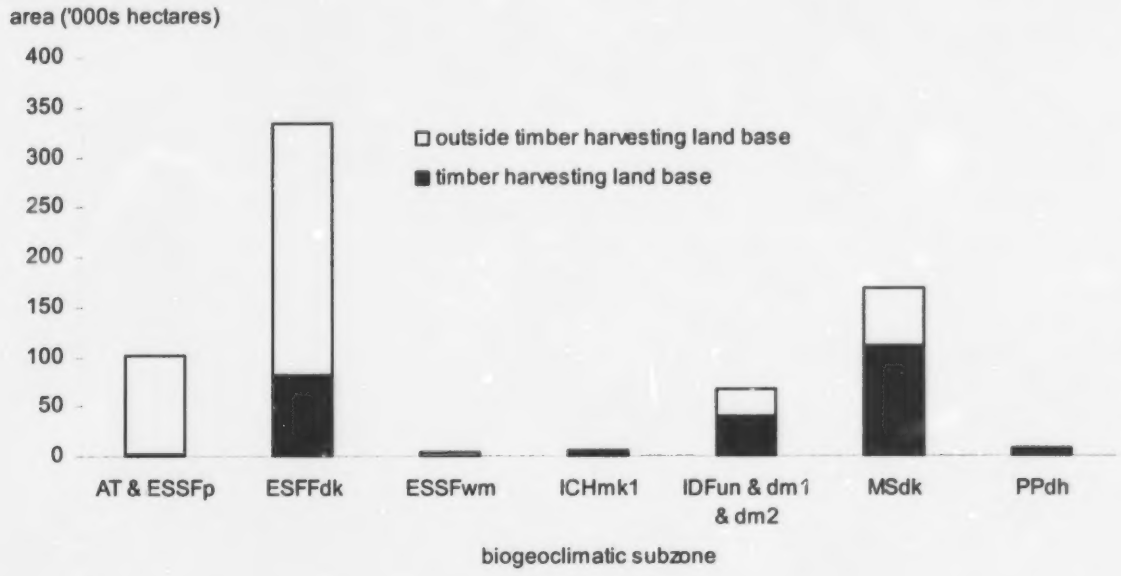


Figure 3. Forested area by biogeoclimatic classification — Invermere TSA, 2000.

2 Information Preparation for the Timber Supply Analysis

Figure 4 shows the current composition of the timber harvesting land base by dominant tree species. Douglas-fir/larch/yellow pine stands on gentle slopes are harvested using partial cut systems, while Douglas-fir/yellow pine stands on steeper slopes are normally clearcut. After harvest, stands are expected to be regenerated to the same species.

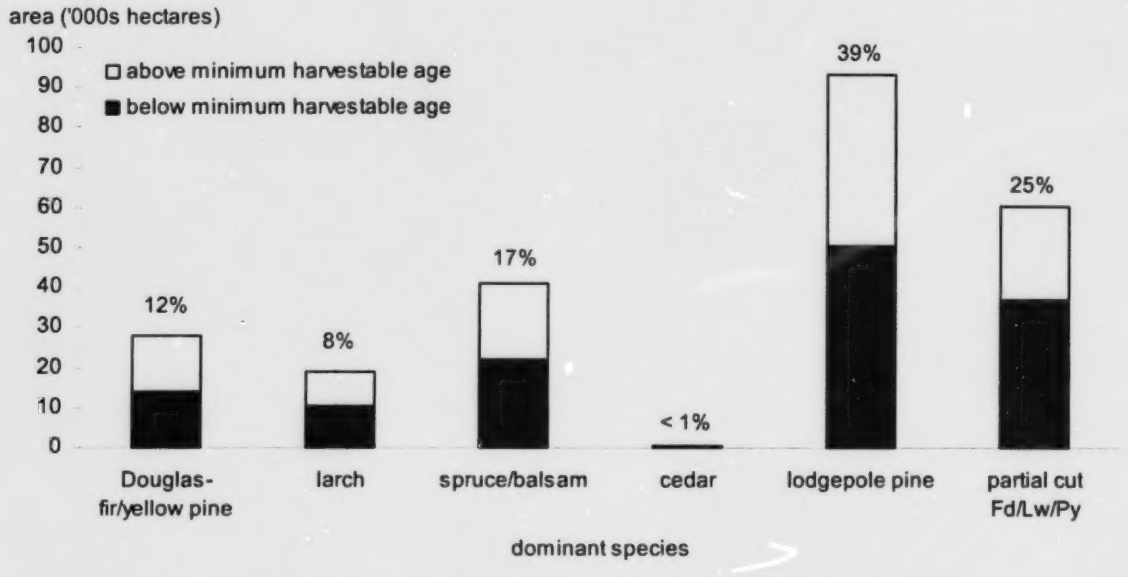


Figure 4. Area by dominant species — Invermere TSA timber harvesting land base, 2000.

Figure 4 also shows the proportion of area of each species that is either younger or older than the minimum harvestable age (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for details on the minimum harvestable age for each species). In total, about 45% of stands in the timber harvesting land base are at or above the minimum harvestable age. There is some variation around this proportion for each of the species groupings: 50% of steeper slope fir/yellow pine stands, 46% of spruce/balsam, larch and lodgepole stands and only 39% of partial cut stands are currently older than minimum harvestable age.

2 Information Preparation for the Timber Supply Analysis

Figure 5 shows the distribution of site productivity of the dominant stand types within the timber harvesting land base. Over all species, 36% of the area is classified as having relatively good site productivity. Stands with medium site productivity occupy 45% of the area, and those with a relatively poor site productivity, 19%. Sites of very low productivity (spruce/balsam stands with site index* less than 8 metres and others with site index less than 10 metres) are excluded from the timber harvesting land base. Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" contains a definition of good, medium and poor site productivity for each of the species groups shown in Figure 5.

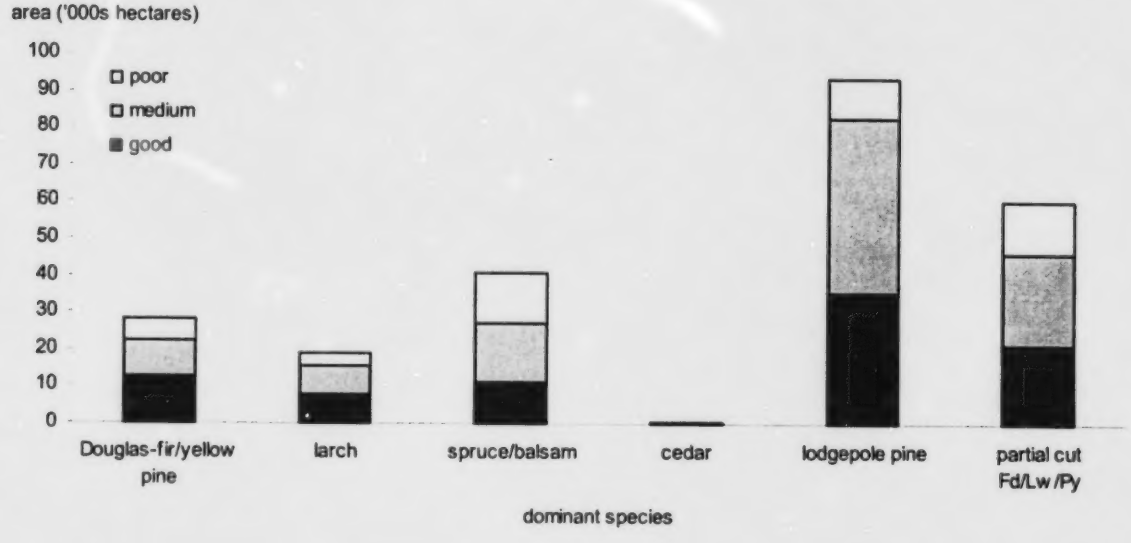


Figure 5. Area by predominant species and site productivity — Invermere TSA timber harvesting land base, 2000.

Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

Figure 6 shows the current age composition of all Crown forested area in the Invermere TSA. Currently, very few stands are older than 250 years both within and outside of the timber harvesting land base. About 16% of the total forested area contains stands 20 years or younger, 34% is between 21 and 100 years old, 44% is between 101 and 250 years of age, and 6% is older than 250 years. In the timber harvesting land base 24% of the stands are 20 years or younger, 39% are between 21 and 100 years old, 35% are between 101 and 250 years of age, and 2% are older than 250 years.

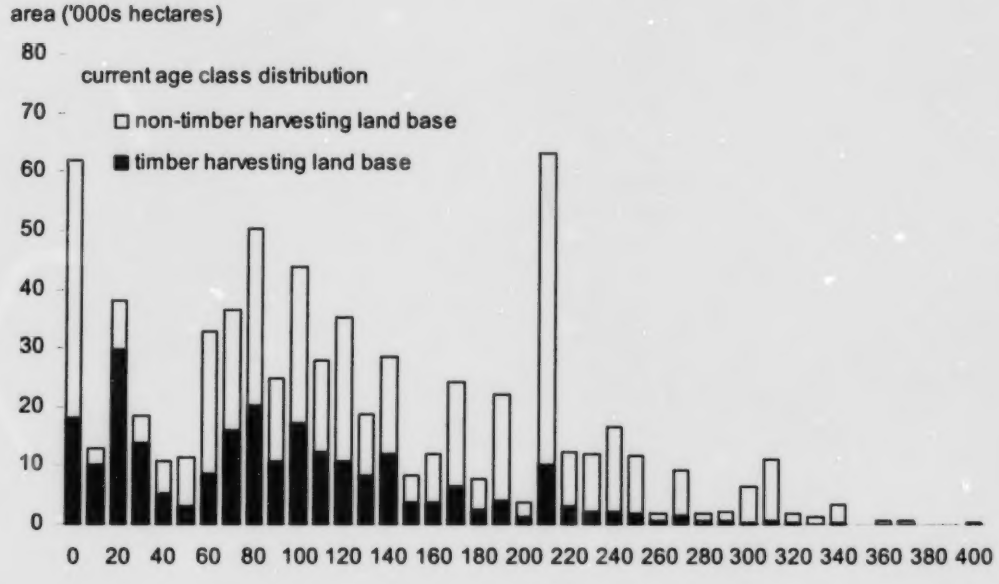


Figure 6. Current age class distribution — Invermere TSA forested land base, 2000.

The age class distribution of forested stands excluded from the timber harvesting land base also affects timber supply. In the case of the Invermere TSA, 50% of the total forest land base is covered by these stands which, although they do not contribute directly to the timber supply, can affect how much harvesting can be conducted, and the pattern of the harvesting within the TSA, by providing old-forest and biodiversity attributes. Only 8% of these "non-timber harvesting land base" stands are older than 250 years. Twelve per cent of the stands are 20 years or younger, 30% are between 21 and 100 years old, and 50% are between 101 and 250 years of age.

2.2 Timber growth and yield

Timber growth and yield refers to the prediction of the growth and development of forest stands over time. Forest stands have many characteristics that change over time that could be the subject of growth and yield (for example, number of trees per area, tree diameter, tree height, and species composition). Since timber supply analysis concentrates on timber volumes available over time, the most relevant measure for this analysis is volume per area (cubic metres per hectare). A timber volume estimate* assumes a specific utilization level, or set of dimensions, that establish the minimum tree and log sizes that are removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree.

Two growth and yield models were used to estimate timber volumes for the Invermere TSA analysis. The variable density yield prediction (VDYP) model developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating volumes in unmanaged coniferous* stands. The table interpolation program for stand yields (TIPSY), developed by the B.C. Forest Service, Research Branch was used to estimate yields for coniferous managed stands. Managed stands were defined as stands less than 31 years of age, and those that will be established in the future.

Volume estimation and prediction is subject to uncertainty due to the procedures used for estimating site productivity, limited experience with second-growth in British Columbia, and the long time frame over which trees grow. Sensitivity analyses described in Section 5, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

Based on timber volume estimates, the current timber inventory on the timber harvesting land base is approximately 34.2 million cubic metres. About 29.3 million cubic metres, or 86%, of the total, are currently merchantable that is, older than minimum harvestable age. The merchantable volume of forests currently greater than 140 years old is approximately 15.5 million cubic metres.

2.3 Management practices

Timber supply depends directly on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined for the timber supply analysis process. The *Forest Practices Code of British Columbia Act* and associated regulations provide the predominant guidance for forest management practices in the Invermere TSA. The focus of the Timber Supply Review is to assess timber supply based on current management practices as implemented in plans for the area. Staff in the Invermere Forest District provided descriptions for the following management practices:

- Silviculture practices — reforestation activities required to establish free-growing* stands of acceptable tree species. Most areas in the Invermere TSA are harvested using either the clearcut harvesting* or the shelterwood system* and restocked by planting as well as natural regeneration.

Volume estimates (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Coniferous
Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

Clearcut harvesting
A harvesting method whereby all trees that meet utilization standards are harvested. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding.
Shelterwood system
Involves leaving a significant proportion of the mature, merchantable trees standing after an initial harvest to provide seed and shelter to assist in establishing a new stand. Usually the shelter trees are harvested after the new stand is well established.

- Incremental silviculture — where necessary, stands are juvenile spaced* to ensure young trees are well distributed to maximize growth. Improved seed from seed orchards is used when possible to increase productivity. There is currently limited availability of seedlings originating from seed orchards in the Invermere TSA, however, there are plans to increase the production for future planting.
- Forest health and unsalvaged losses* — timber losses to fire and pest (insect) damage are expected to average 20 119 cubic metres per year for the foreseeable future.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.
- Patch-size distribution and green-up* — in the Invermere TSA, approval of clearcut harvesting activities is contingent on previously harvested adjacent stands reaching a desired condition, or green-up (three metres in height for integrated resource management (IRM)* areas). The purpose of patch-size distribution guidelines is to have a variety of different-sized openings spread across the landscape. This analysis does not model patch-size distribution, but the objective to prevent timber harvesting from becoming overly concentrated in any landscape unit is incorporated by limiting the area that does not meet green-up conditions to a maximum of 25% in the IRM area.
- Caribou habitat is protected by ensuring that at least 40% of the area identified as caribou habitat is covered by forest greater than 140 years old and at least 10% of the forest is greater than 250 years old. There are also provisions that no more than 25% of the forest can be less than three metres tall.
- Ungulate winter range — in addition to the caribou habitat, areas identified as ungulate winter range (UWR) are required to have at least 40% of the forest greater than 120 years of age as well as meet the green-up requirements of no more than 25% of the forest less than three metres tall.
- Protection of environmentally sensitive areas — areas where potentially unstable soils, avalanche tracks, recreation activities, forest regeneration problems and habitat for various wildlife have been identified. To maintain ecological or other resource values, this land has been removed from the timber harvesting land base as detailed in Appendix A.
- Community watersheds — within community watersheds a maximum of 20% of the area may be less than the green-up height of six metres. Community watersheds cover 18% of the timber harvesting land base and may overlap with areas managed for ungulate winter range.

Juvenile spacing
A silvicultural treatment to reduce the number of trees in young stands, often carried out before the stems removed are large enough to be used or sold as a forest product. Prevents stagnation and improves growing conditions for the remaining crop trees so that at final harvest the end-product quality and value is increased.
Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.

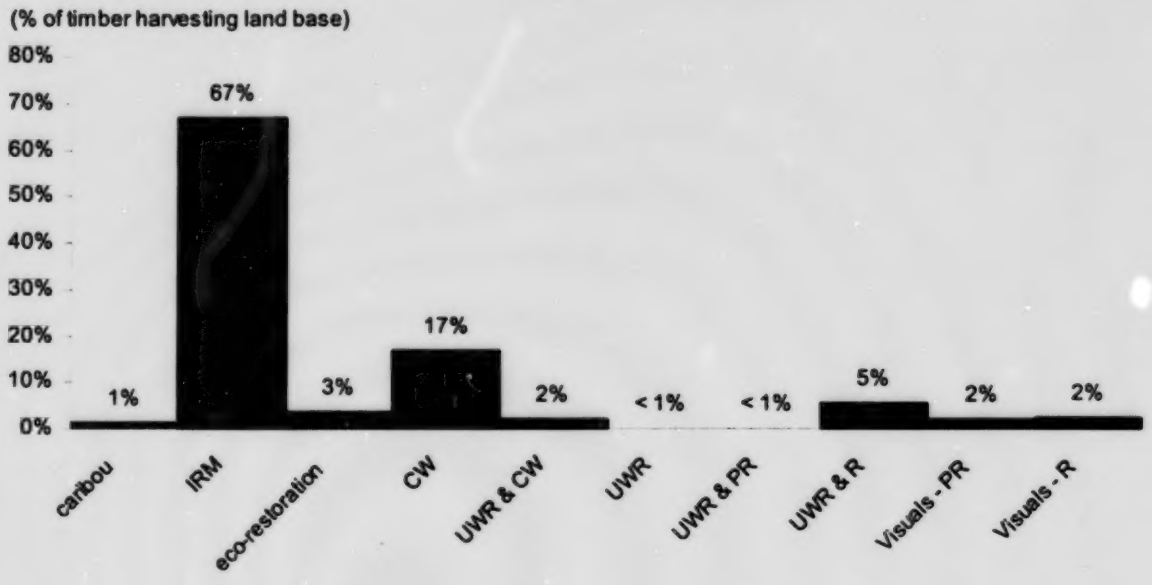
Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Integrated resource management
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

- Maintenance of scenic values — maintaining important scenic values requires that visible evidence of harvesting be kept within limits in some areas of the Invermere TSA. The maximum proportion of each scenic area* that may be covered by young stands that do not meet green-up requirements varies depending on the forest characteristics, average slope and the visual quality class (VQC) for each area. In areas classified as VQC retention, 5% may be less than 4 to 8.5 metres tall depending upon slope, whereas 15% may be less than 4 to 8.5 metres tall in partial retention classes.
- Minimum harvestable ages (MHA) — the time it takes for stands to grow to a merchantable condition. The criteria used to define minimum harvestable ages included minimum volume per hectare, minimum piece size, and achievement of 95% of culmination mean annual increment* (CMAI). Actual harvest age may be greater but not less than the minimum, and will depend on ages of other available stands, forest cover objectives* and overall timber harvest targets.
- Landscape-level biodiversity* — to maintain biological diversity throughout a landscape unit, the *Forest Practices Code* contains targets for the proportion of the area in each biogeoclimatic variant that should be covered by stands with old- and mature-forest characteristics. The Invermere Forest District has operationally implemented landscape units and biodiversity emphasis options for biogeoclimatic variants within the Invermere TSA and is soon to complete the legal process of establishing them (see Section A.4.10, "Forest cover requirements" in Appendix A for details regarding landscape-level biodiversity).
- The Invermere Enhanced Forest Management Pilot Project (EFMPP) began in early 1996. Managed by the Ministry of Forests, it forms about 25% of the TSA in the southeastern corner. The main goal of the EFMPP is to develop enhanced management strategies at the forest level. Currently the key activity of the project is to implement components of the management strategies report produced in November 1998 and the completion of ongoing research.

Scenic area
Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Mean annual increment (MAI)
Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.

Forest cover objectives
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see ***Green–up****).*
Landscape-level biodiversity
The Landscape Unit Planning Guide *provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.*

Figure 7 shows the proportions of the timber harvesting land base subject to different forest management objectives and the extent of overlapping objectives. The percentages shown in Figure 7 are only for the timber harvesting land base portion of that management objective.



IRM = integrated resource management;
CW = community watersheds;
UWR = ungulate winter range;
PR = partial retention;
R = retention.

Figure 7. Timber harvesting land base by management emphasis — Invermere TSA timber harvesting land base, 2000.

3 Timber Supply Analysis Methods

The Forest Service Simulator (FSSIM) model version 3.0 was used for this analysis. The simulation model uses information about the timber harvesting land base, timber volumes, and the management regime to represent how trees grow and are harvested over a long period of time. Only the results for the first 250 years are shown graphically in this report because the harvest level remains constant after that time.

Similar to other models, the FSSIM model assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst, such as harvest volume maximization. FSSIM also allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of green-up prescriptions and requirements for older forest. For example, guidelines might specify that no more than some maximum percentage of the forest can be younger than a specified green-up age, or that some minimum percentage of the forest must be in older age classes to provide wildlife habitat.

This type of analysis is used to determine the timber supply implications of a particular forest management regime. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and that will assist local B.C. Forest Service staff to administer their programs according to relevant guidelines and principles. However, the results of the analysis are not meant to be taken as recommendations of any particular AAC.

The main results of the analysis are forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time. Although this information gives field staff only very limited guidance in the design of operational activities such as harvesting block location and silviculture planning, it does help ensure that the timber harvest level supports rather than hinders sustainable forest management in the field.

4 Results

This section presents results of the timber supply analysis for the Invermere TSA. The base case harvest forecast* detailed in Section 4.1 uses the most recent assessments of current forest management, land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation for the Timber Supply Analysis." Because forest management is inherently a long-term venture, uncertainty surrounds much of the information important in determining timber supply. This uncertainty will be discussed in Section 5, "Timber Supply Sensitivity Analyses." The base case* provides only a part of the timber supply picture for the Invermere TSA, and should not be viewed in isolation of the sensitivity analyses*.

4.1 Base case and alternative harvest forecasts

As explained earlier the current AAC for the Invermere TSA is 591 500 cubic metres per year, but because of the removal of woodlot licence areas with a cumulative AAC of 9930 cubic metres from the TSA, this report considers the current AAC attributable to the TSA to be 581 570 cubic metres per year. Figure 8 shows the base case harvest forecast. This analysis suggests that a harvest level of 581 570 cubic metres per year can be maintained for one decade followed by a reduction in the harvest level over the subsequent two decades to 426 881 cubic metres per year. Unsalvaged losses due to natural forces such as insects and fire are estimated to be 20 119 cubic metres per year throughout the planning horizon and have been subtracted from all harvest forecasts shown in this report.

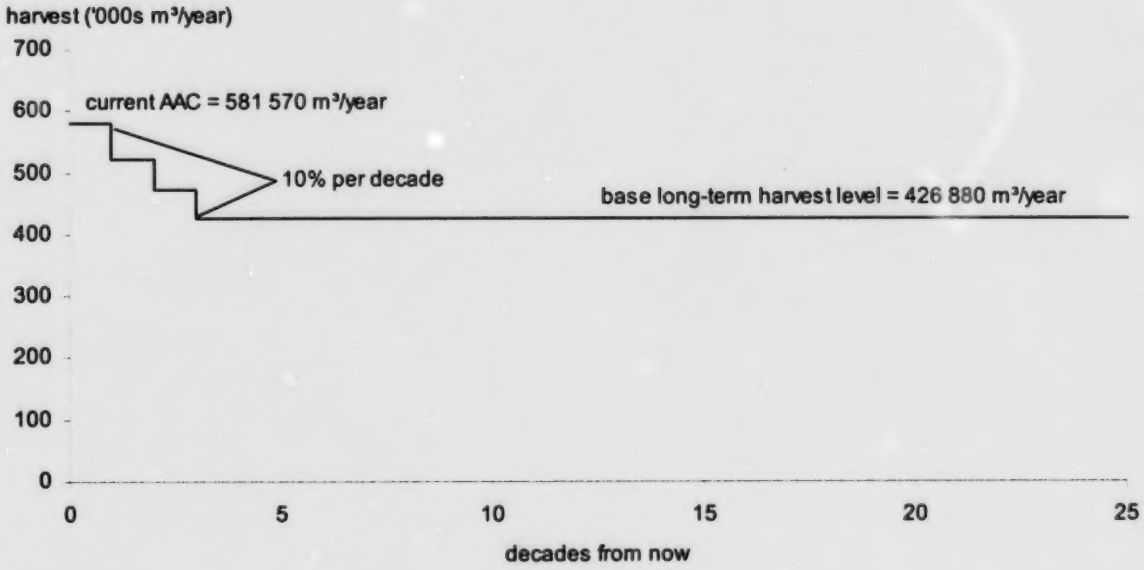


Figure 8. Base case harvest forecast for the Invermere TSA, 2000.

Harvest forecast
The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

Base case
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

Sensitivity analysis
A process that examines how uncertainty in data and management assumptions affect timber supply.

4 Results

Several harvest forecasts are possible for the Invermere TSA within the current management regime described in previous sections. Prior to selecting the base case, a number of forecasts were developed to analyse the potential timber supply for the TSA. Figure 9 presents some of these forecasts, and the following paragraphs describe how the alternative forecasts were evaluated, and how the final selection of the base case harvest forecast was made.

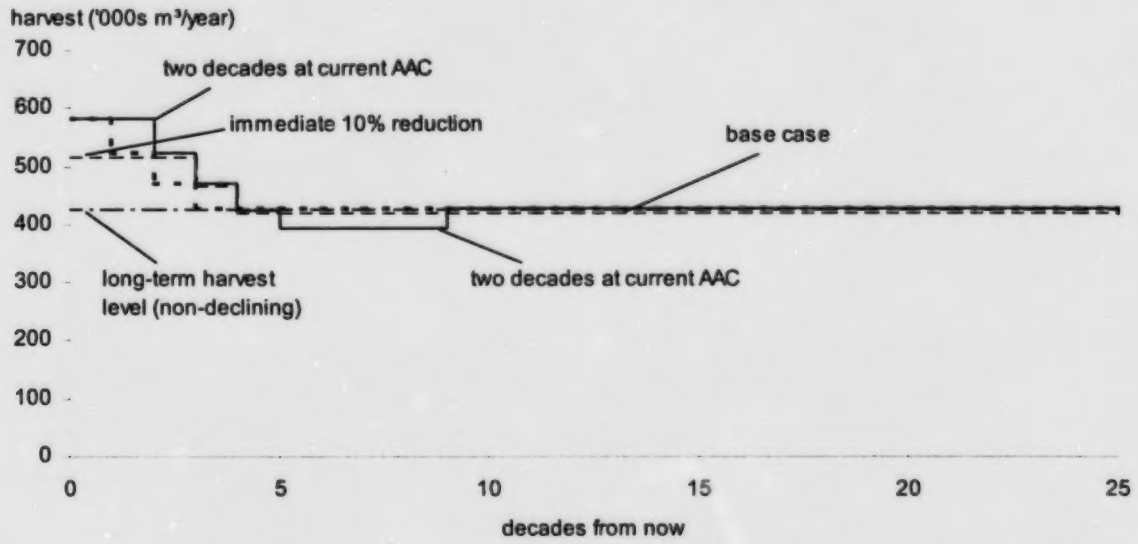


Figure 9. Alternative harvest flows — Invermere TSA, 2000.

One forecast tested the feasibility of a non-declining harvest flow. The continuous harvest level for this forecast was approximately 427 000 cubic metres per year, 27% lower than the current AAC but just under 200 cubic metres higher than the base case long-term harvest level*. Over the first three decades, this non-declining flow projected a total harvest of 2 950 000 cubic metres less than that obtainable in the base case.

A second forecast tested the feasibility of maintaining the current AAC for as long as possible without causing severe timber shortages in the future. Results show that it is possible to maintain the current AAC for only two decades before declining to 394 881 cubic metres per year and maintaining that level until decade 10 when the forecast rises 7.5% to the base case long-term harvest level of 426 881 cubic metres. For the first nine decades, the total harvest projected in this forecast was slightly lower — 237 729 cubic metres or 0.5% — than in the base case.

A third alternative tested the medium-term implications of lowering the harvest immediately by 10% to 523 413 cubic metres per year. It was possible to maintain this harvest level for three decades before following the same declining harvest projection as shown in the base case. For the first nine decades, this forecast projects a total harvest of 41 757 000 cubic metres or 0.9% more than that shown in the base case.

Long-term harvest level
A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

Total timber supply is slightly higher in two of the alternate forecasts than in the base case. However, the base case is the only forecast in which an immediate downward adjustment is not required and the harvest is always at or above the long-term harvest level. All others require either an immediate adjustment, future harvests below the long-term harvest level, or both.

The base case also provides for an orderly transition from harvesting existing natural stands to managed (harvested and regenerated) stands. For these reasons, the harvest flow showing one decade at the current AAC was chosen as the base case for further analysis.

4.1.1 Base case timber supply dynamics

As shown by the current age composition (Figure 6), the forest in both the timber harvesting land base and the non-timber harvesting land base is distributed across all age classes, with 45% of the timber harvesting land base at or above the minimum harvestable ages. Figure 10 shows that this distribution enables a relatively smooth transition of harvest from existing natural stands to managed stands for the base case. The transition from existing to managed stands starts at the beginning of decade 5 and by decade 8 the contribution from managed stands comprises more than one-half the total harvest from the Invermere TSA. By decade 18, managed stands contribute about 90% of the harvest.

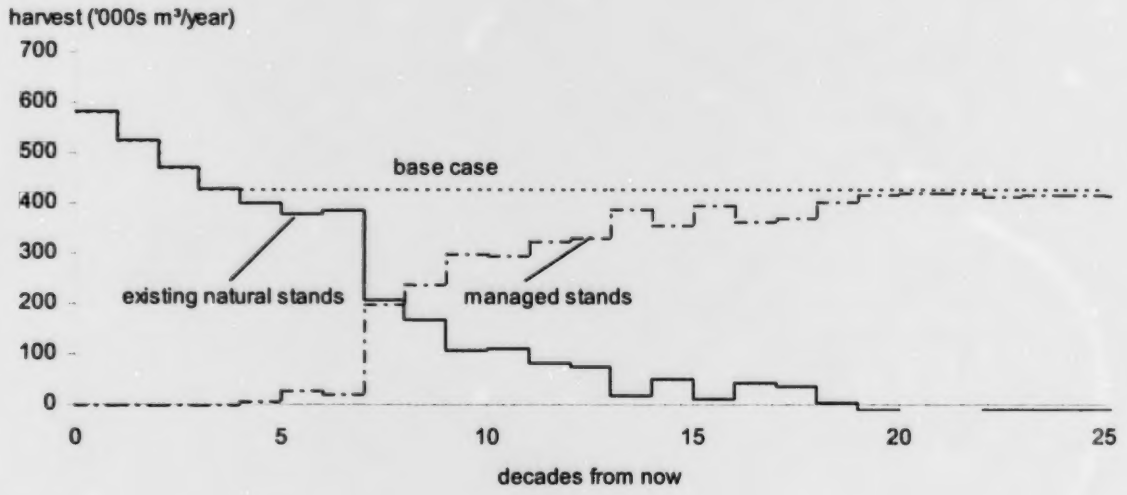


Figure 10. Harvest contribution from the unmanaged and managed stands — Invermere TSA, 2000.

Normally, achievement of the long-term harvest level is associated with the time when managed stands constitute most of the harvest. However, in this base case the long-term harvest level is reached before managed stands contribute significantly to timber supply. In the Invermere TSA, volumes in existing merchantable stands are sufficient to maintain timber supply above the long-term level for a few decades, and to maintain medium-term harvests at the long-term harvest level while managed stands grow to a merchantable size.

4 Results

Figure 11 tracks the growing stock* from managed stands and from existing natural stands. Some partial harvesting managed stands are merchantable at present but are not harvested until decade 5. Existing unmanaged stands still contribute to the merchantable growing stock well into the future largely because of the slow rate of harvest from the ungulate winter habitat zone.

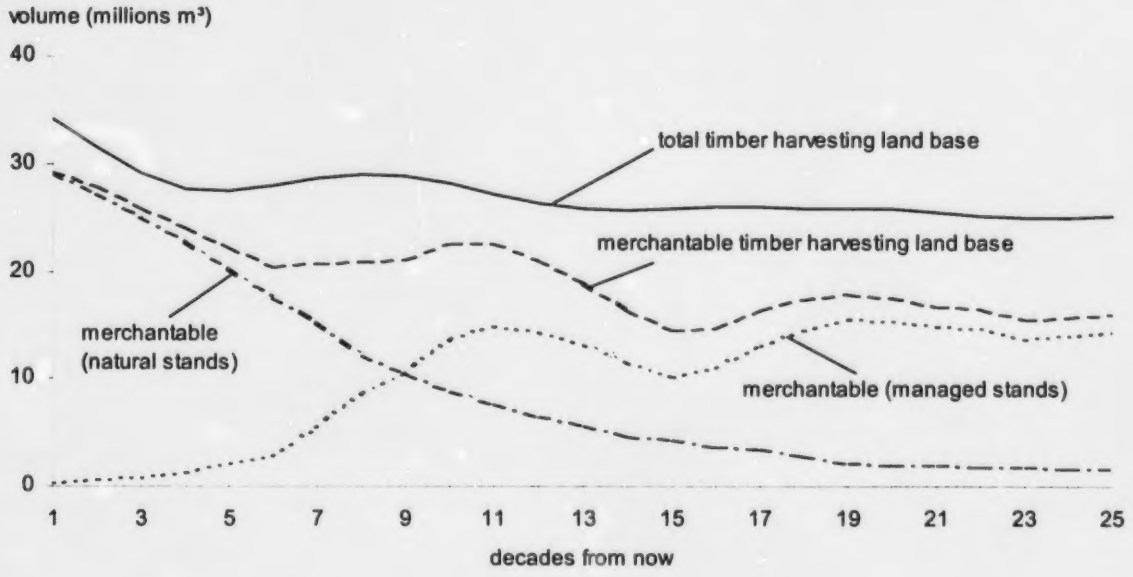


Figure 11. Total and merchantable growing stocks — Invermere TSA, 2000.

Growing stock
The volume estimate for all standing timber at a particular time.

4.2 Average age, area, and volume harvested

Figure 12 tracks the change in the area-weighted average harvest age resulting from the base case forecast. The pattern of harvested age over the first two periods reflects that the highest harvest priority during modelling was given to pine stands furthest above their minimum harvestable age (relative oldest first). The fourth period spike results because of increased availability of old stands after cover requirements are achieved by relatively younger stands. The reduction in average ages in decades 5 through 9 reflect the increase in harvest of younger managed stands. Thereafter, the area-weighted average harvest age fluctuates around 113 years.

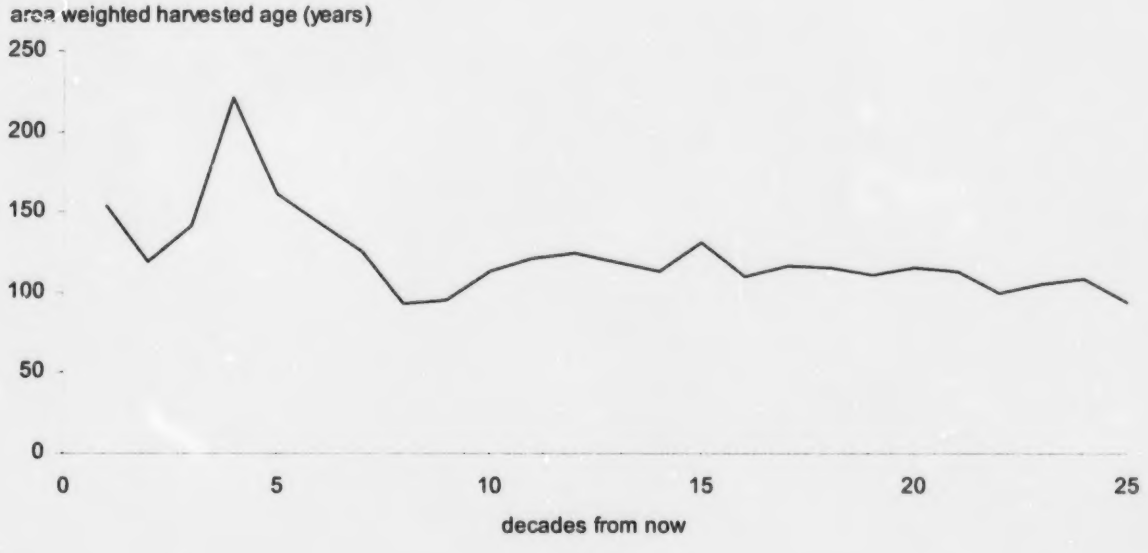


Figure 12. Average age of stands harvested over time — Invermere TSA base case, 2000.

4 Results

Figure 13 shows the average volume per hectare harvested while Figure 14 shows the average area harvested per year over the next 250 years under the base case harvest forecast. The average volume per hectare varies from the highest of 284 cubic metres per hectare in decade 4 coincident with the lowest average area harvested of 1572 hectares per year, to the lowest average volume per hectare of 169 cubic metres per hectare in decade eight coincident with the highest average area harvested of 2639 hectares per year.

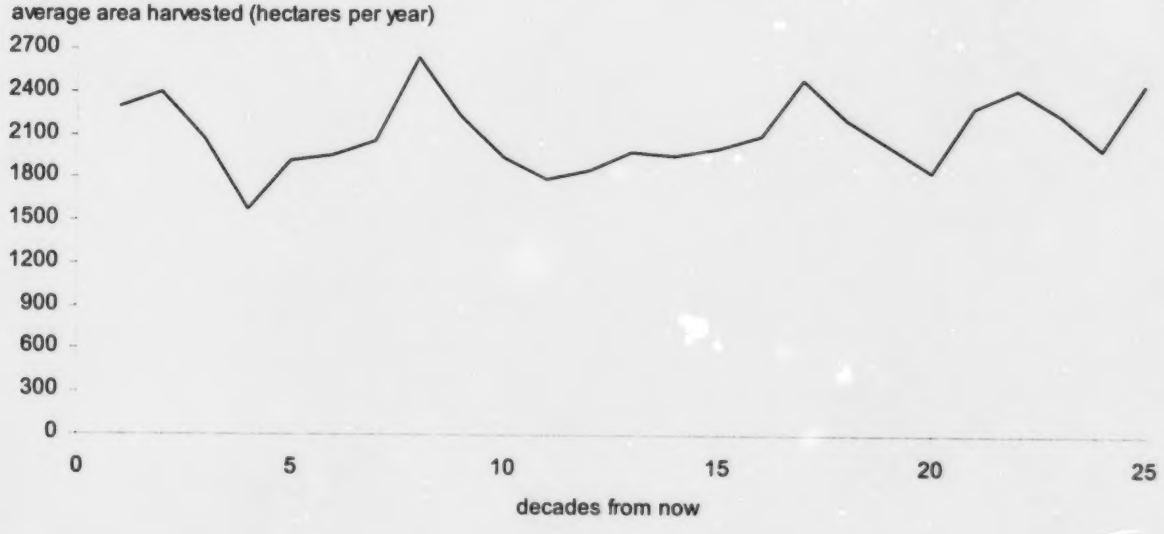


Figure 13. Average area harvested over time — Invermere TSA base case, 2000.

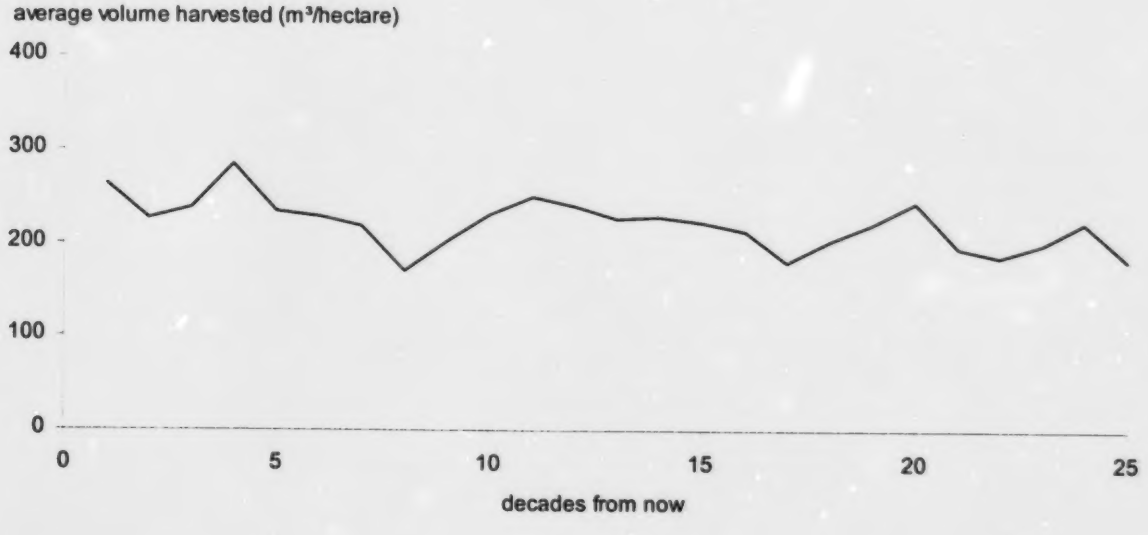


Figure 14. Average volume per hectare harvested over time — Invermere TSA base case, 2000.

4.3 Age class profile over time

The charts in Figure 15 show how the age composition of the forest both in the timber harvesting land base and in the non-timber harvesting land base of the Invermere TSA is projected to change over time under the base case harvest forecast.

The current age class distribution shows that stands within the timber harvesting land base are distributed across all age classes, a notable gap being evident for age classes 50 and 60. There is a significant amount of forest at 220 years old, but only 2% of the forest in the timber harvesting land base is greater than 250 years old.

Outside of the timber harvesting land base, the stands have a similar distribution to that of the timber harvesting land base only with wider variation. The significant area currently in stands of age 10 or younger represents the large fires of 1985. The large amount at age 210 years is due to fire history in the late 1700s. The non-timber harvesting land base has only 8% of area currently greater than 250 years old.

One consequence of the small proportion of stands greater than 250 years is that the old-growth requirements for landscape-level biodiversity in the Interior Douglas-fir and Ponderosa Pine BEC zones are not met in the early periods of the harvest forecast. This lack of older forest in some biogeoclimatic variants in some landscape units does not necessarily mean that some merchantable forest in the timber harvesting land base must be reserved from harvest in perpetuity. The forest estate model used by the B.C. Forest Service reserves some of the older forest from the timber harvesting land base needed to meet old-growth objectives until stands outside the timber harvesting land base can meet the requirements. There is a substantial area close to the 250-year threshold which can be reserved to meet old-growth requirements. Since 45% of forest on the timber harvesting land base is currently at or above minimum harvestable age, there are sufficient merchantable stands available to meet the harvest forecast during the waiting period. Reserving of stands for a long time extends the period over which existing stands are harvested, and results in small fluctuations around average volume and average area harvested into the long term.

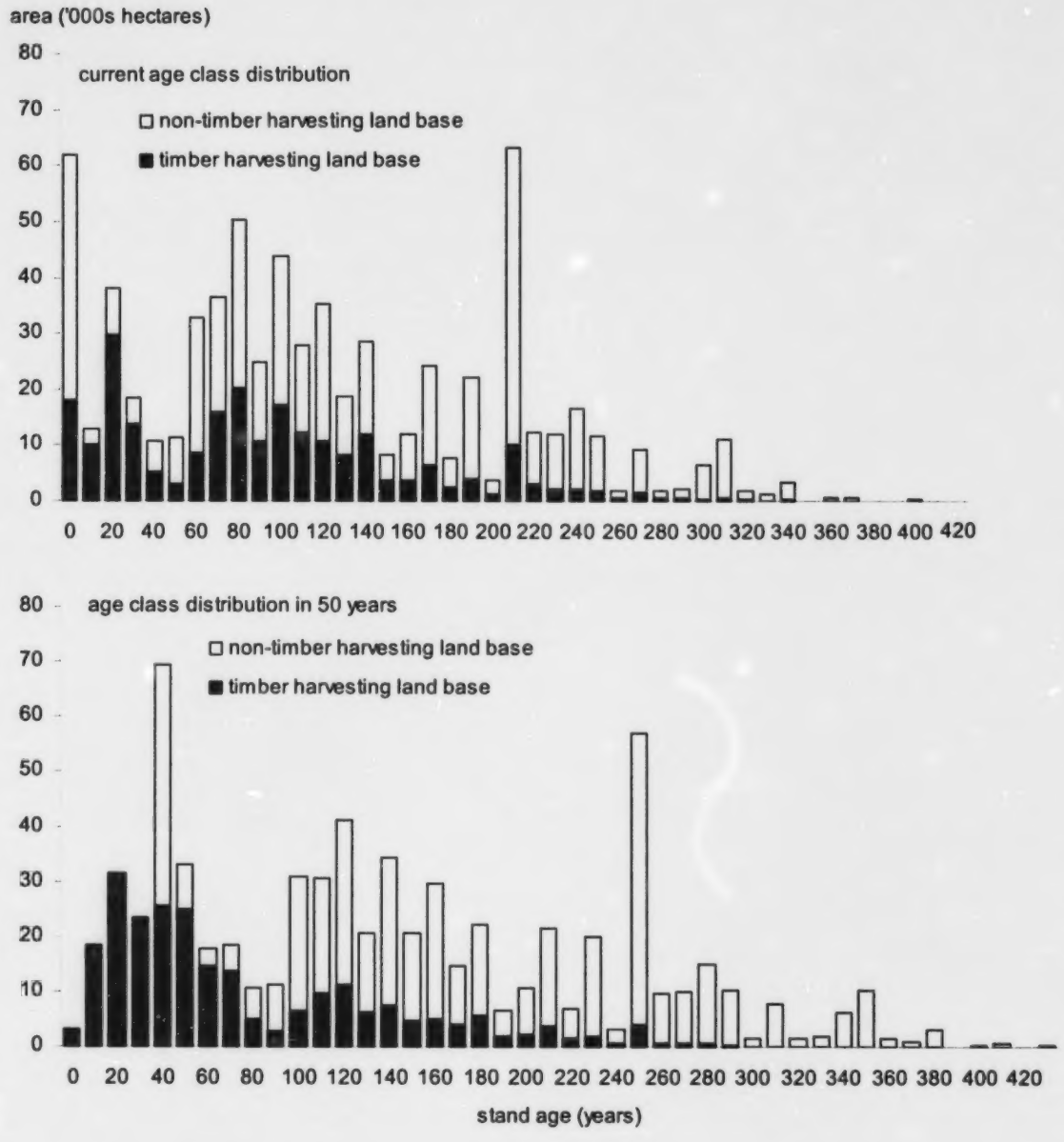

area ('000s hectares)
current age class distribution
non-timber harvesting land base
timber harvesting land base
0 10 20 30 40 50 60 70 80
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420
age class distribution in 50 years
non-timber harvesting land base
timber harvesting land base
0 10 20 30 40 50 60 70 80
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420
stand age (years)

Figure 15. Changes in age distribution on the productive land base over time — Invermere TSA base case, 2000.

(continued)

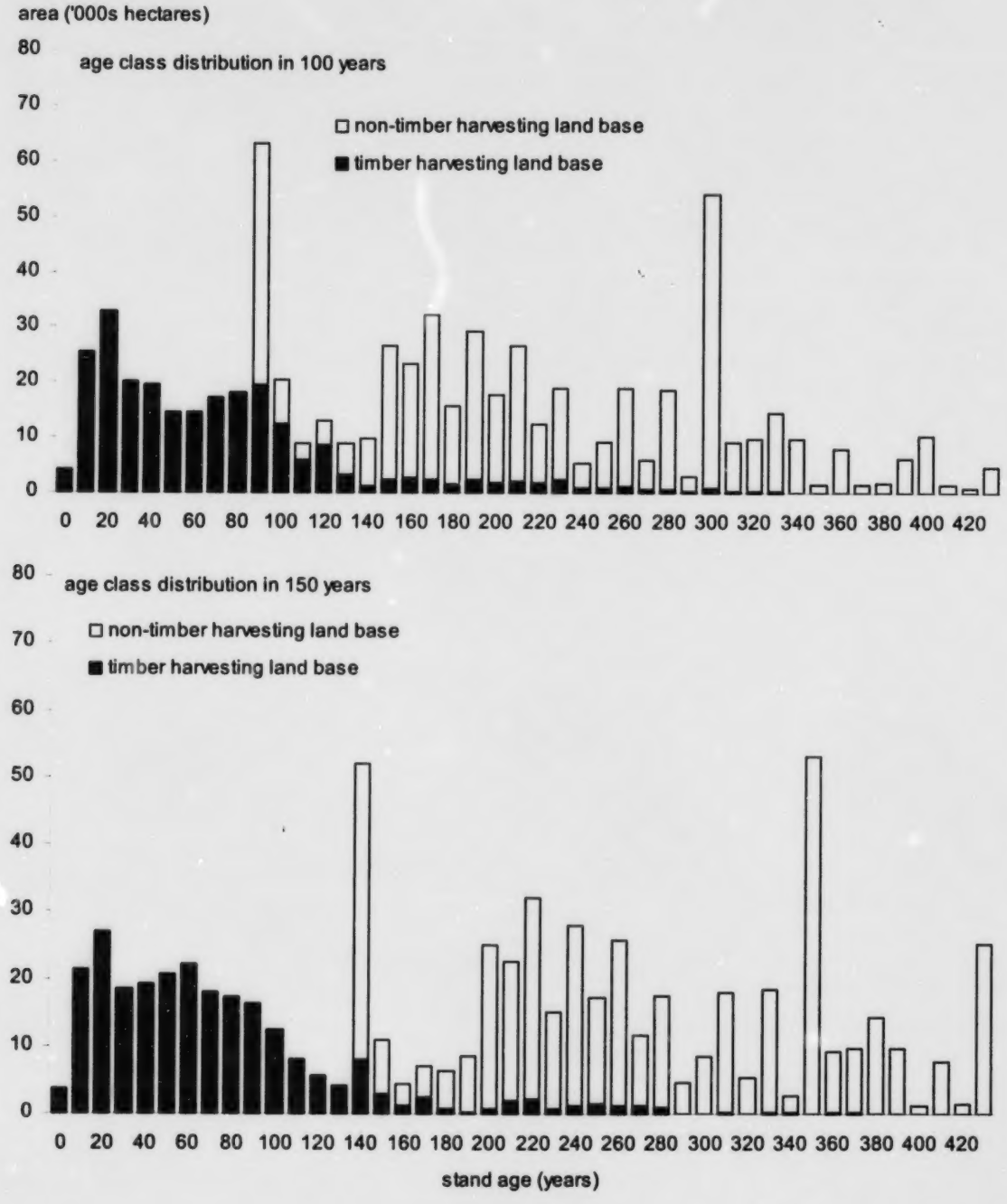

area ('000s hectares)
age class distribution in 100 years
non-timber harvesting land base
timber harvesting land base
0 10 20 30 40 50 60 70 80
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420
age class distribution in 150 years
non-timber harvesting land base
timber harvesting land base
0 10 20 30 40 50 60 70 80
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420
stand age (years)

Figure 15. Changes in age distribution on the productive land base over time — Invermere TSA base case, 2000.

(continued)

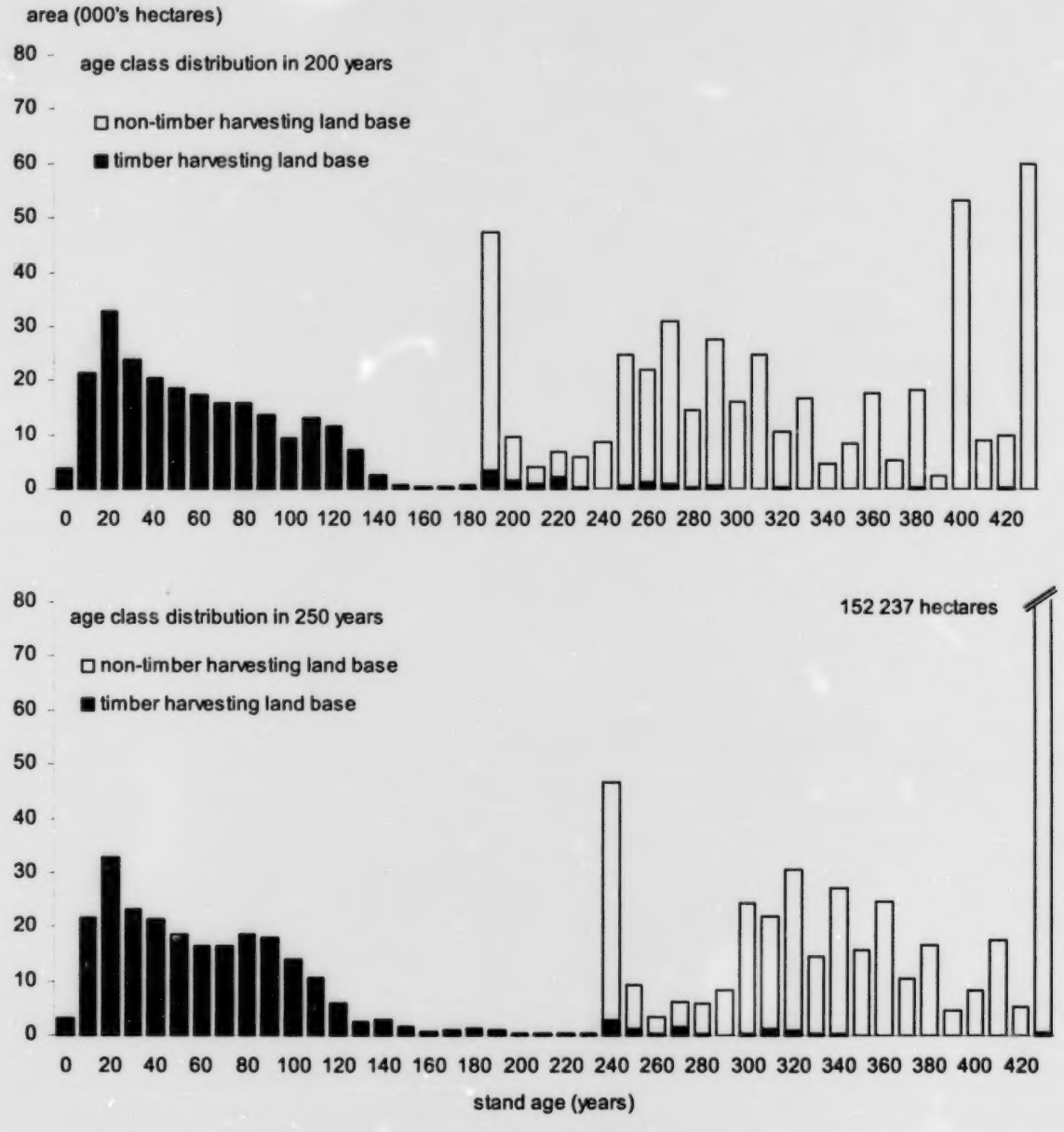

area (000's hectares)
age class distribution in 200 years
non-timber harvesting land base
timber harvesting land base
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420
age class distribution in 250 years
152 237 hectares
non-timber harvesting land base
timber harvesting land base
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420
stand age (years)

Figure 15. Changes in age distribution on the productive land base over time — Invermere TSA base case, 2000.

(concluded)

5 Timber Supply Sensitivity Analyses

The best available information on forest inventories and management practices was used to analyse the timber supply implications of continuing with current management. However, forest management is a complicated endeavour that must account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow quite slowly in terms of human time spans, which means that decisions we make today have not only short-term but also long-term effects. In such a context, we cannot be certain that all the data accurately reflect the current state of all values in the forest, how the forest will change, or how our management activities will affect the forest.

One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision-making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed. This is often referred to as "adaptive management."

Another important way of dealing with uncertainty is to assess how values of interest, for example, timber supply, could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. It can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. Sensitivity analysis can clarify whether current best estimates provide a safe basis for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

In this section, results of several sensitivity analyses are discussed. Sensitivity analyses are intended primarily to test the relative change (i.e., high *versus* low sensitivity) in the harvest forecast resulting from changes in forest management assumptions and data used in the base case.

5.1 Uncertainty in the area of the timber harvesting land base

Uncertainty in the size of the timber harvesting land base is due to factors such as fluctuations in timber prices, changes in harvesting and milling technology and land-use decisions.

Another factor is the uncertainty around the use of regional or provincial averages in defining the land base when localized data are not available. For example, detailed wildlife tree* patch (WTP) mapping to assist in managing for stand-level biodiversity* is not available for the Invermere TSA. Therefore, a classification system was used to estimate the extent and the appropriate reductions for WTPs on the timber harvesting land base.

Currently it is not known if the timber harvesting land base has been over- or under-estimated, so two sensitivity analyses were performed. The first evaluates the outcome of shifting 12 088 hectares of the non-timber harvesting land base to the timber harvesting land base, thereby increasing it by 5%. The second evaluates the outcome of shifting 5% (12 088 hectares) of the timber harvesting land base to the non-timber harvesting land base.

Wildlife tree
A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Stand-level biodiversity
A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.

5 Timber Supply Sensitivity Analyses

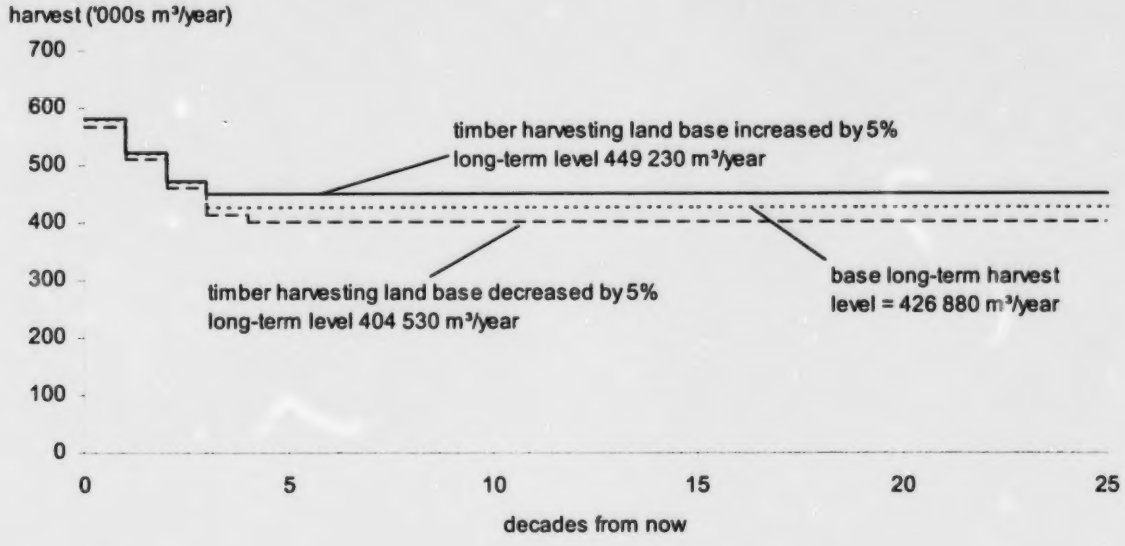


Figure 16. Land base sensitivity analysis — Invermere TSA, 2000.

The sensitivity analysis shows that if the base case over-estimated the timber harvesting land base by 5%, that an immediate 2% reduction is required, followed by 3 decades of 10% per decade stepwise declines to medium- and long-term levels approximately 5% lower than in the base case. If the timber harvesting land base is larger than in the base case, the transition to harvesting predominately second-growth managed stands is somewhat delayed and the long-term harvest level is 449 230 cubic metres per year, 5% higher than in the base case.

5.2 Uncertainty in the estimated time to green-up

Forest cover requirements* for visual quality, wildlife habitat, water quality and adjacency applied in this analysis involve estimates of when stands will reach green-up conditions, expressed as the desired height of a stand (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for desired green-up heights for each management emphasis area).

Forest cover requirements
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see ***Green–up****).*

Green-up age, the age at which a stand exhibits the required height, was determined for the Invermere TSA by examining the height growth of regenerating stands throughout the Invermere TSA in 1997. The green-up period includes both the green-up age and the regeneration delay*, or time taken to establish a stand after harvesting. Uncertainty about green-up period arises because the desired green-up condition (that is, tree height) may either exceed or fall short of requirements, the period of stand establishment may vary, and variations in local stand growth from the regional average may result in stands reaching the desired condition sooner or later than estimated.

Within the range tested, timber supply is not sensitive to changes in the time to green-up in the integrated resource management zone (a decrease of 2 years, and an increase of 5 years were tested). The effects of the green-up time required for other management zones were not tested. The effects of the management objectives applicable to these zones are reviewed in Section 5.5, "Uncertainty in the estimates of management zone objectives."

Regeneration delay
The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.

5 Timber Supply Sensitivity Analyses

5.3 Uncertainty in estimated existing stand yields

Timber volume estimates for existing unmanaged stands are subject to uncertainties in the forest inventory used to estimate timber volumes (i.e., estimated tree heights and stand ages), and the statistical process used to develop the equations for predicting forest growth and yield. Although no specific issues were identified during the 1996 inventory audit of the Invermere TSA, a standard sensitivity analysis was performed to test the potential effect on timber supply of changes in the estimates of existing unmanaged stand volumes. Figure 17 presents the results of decreasing and increasing existing unmanaged stand yield estimates by 10%.

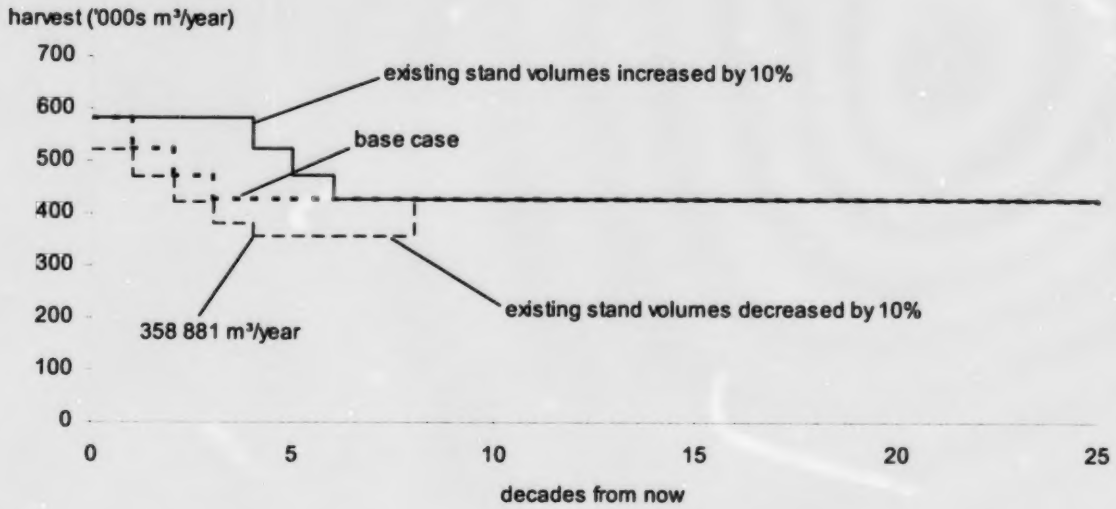


Figure 17. The effect on the harvest forecast of increasing and decreasing volume estimates for existing unmanaged stands by 10% — Invermere TSA, 2000.

With harvest flow guidelines similar to those used to establish the base case, and volumes 10% lower than in the base case, an initial harvest level of 523 413 cubic metres per year (10% lower than the current AAC) is possible. This timber supply then declines to 358 881 cubic metres per year by decade five before rising to the base case long-term level in decade nine.

When existing unmanaged stand volumes are increased by 10%, the initial harvest level can be maintained for four decades before declining to the base case level over two decades.

5.4 Uncertainty in estimated managed stand yields

Uncertainty in volume estimates for managed stands exists for the same reasons listed for estimated existing stand yields (possible inaccuracies in the forest inventory and the growth and yield models), and also because of the limited experience and data available for regenerated managed stands in B.C. There is also uncertainty around the site productivity assigned to older unmanaged stands relative to the site productivity exhibited by the stands after they regenerate. This issue is examined in Section 5.9, "Uncertainty in the productivity of current old-growth sites after harvest."

Issues related to partial cutting were analysed and the findings discussed in Section 5.8, "Uncertainty in the amount of partial harvesting."

5 Timber Supply Sensitivity Analyses

There is traditionally a large incremental silviculture program in the Invermere TSA. The bulk of this work has been in juvenile spacing and the majority of benefits are reflected in the base case. For instance, it is assumed that no losses in productivity due to repression will be experienced. This assumption alone requires spacing of between 500 and 1500 hectares annually in 1985 wildfire areas. Despite uncertain funding, this requirement is expected to be met. Recent harvesting, which has been subject to maximum density requirements, means it is reasonable to assume that losses to repression will be minimal.

From 1996 to 2000, 2.4 million improved orchard seeds were sown for the TSA with an average genetic worth of 1.084 (i.e., an average 8.4% increase in volume yield at rotation age). That is approximately 480 000 seedlings annually with an upward trend due to the availability of larch seed for the first time this year. The genetic worth is also on an upward trend from 6.8% in 1996 to 11.2% in 2000.

Currently 480 000 seedlings equates to approximately 350 hectares of harvested area, representing about 13% of the annual harvest (assuming clearcutting or similar system, and average site productivity). At present trends of improved seedling production, the gain is expected to average 10% in ten years. A 10% genetic worth, applied to 13% of the harvested land base, provides about 1.3% gain in expected long-term yield.

This gain was not factored into the base case; rather its effects can be estimated from the sensitivity analysis of managed stand volumes depicted in Figure 18.

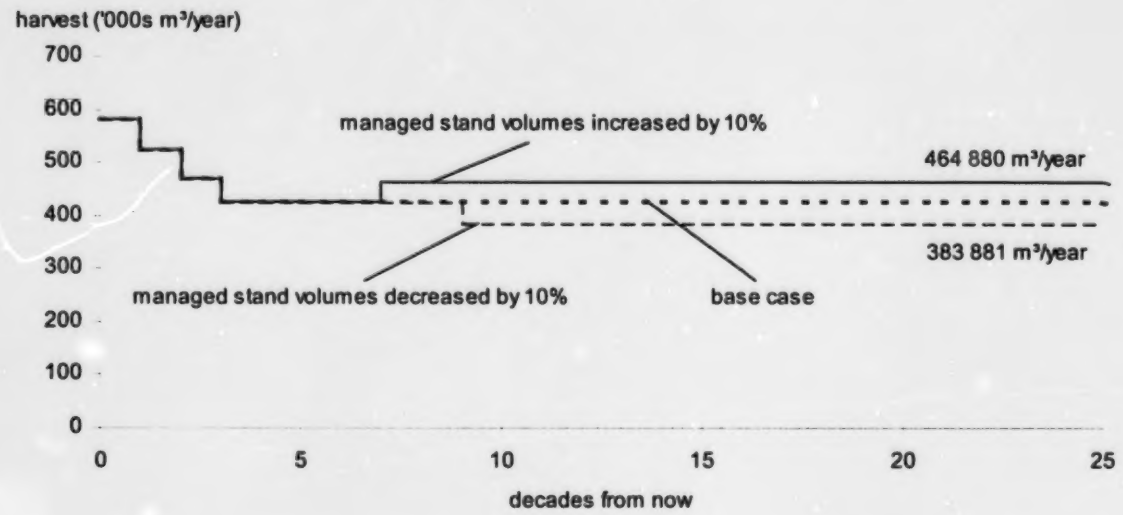


Figure 18. The effect on the harvest forecast of increasing and decreasing volume estimates for managed stands by 10%— Invermere TSA, 2000.

5 Timber Supply Sensitivity Analyses

As factors other than the silvicultural regime could also affect future yields, a sensitivity analysis, in which managed stands yields were increased and decreased by 10%, was performed. For this sensitivity analysis, only the estimated yields were altered; other variables, such as minimum harvestable age that could be affected by stand volume and contributions to green-up were not changed. The results are presented in Figure 18. When yields are decreased by 10%, the harvest decreases to a long-term harvest level of 383 881 cubic metres per year by the ninth decade and remains at this level for the remainder of the planning horizon. When yields are increased by 10%, the long-term harvest level increases by 10% to 464 880 cubic metres per year beginning in the seventh decade.

5.5 Uncertainty in the estimates of management zone objectives

In the Invermere TSA analysis, the land base is classified into seven distinct management zones with associated objectives for managing non-timber values as well as timber harvesting. The specific objectives are detailed in Table A-19. of Appendix A.

Figure 7, presented earlier in this report, depicts their relative extent across the timber harvesting land base as well as the degree to which they overlap. The integrated resource management, eco-restoration, community watershed, partial retention visuals and retention visuals zones have specific green-up objectives specifying varying maximum percentages allowed under a specified age. The ungulate winter range and caribou zones have specific mature and old-growth forest cover objectives requiring varying minimum percentages above specified ages.

Ungulate winter range objectives are the only non-timber requirements to which the base case is sensitive. Changing the objectives that apply to the winter range to those of the IRM zone allows the forecast to continue at the current AAC for three decades before declining parallel to the base case to the long-term harvest level in decade six.

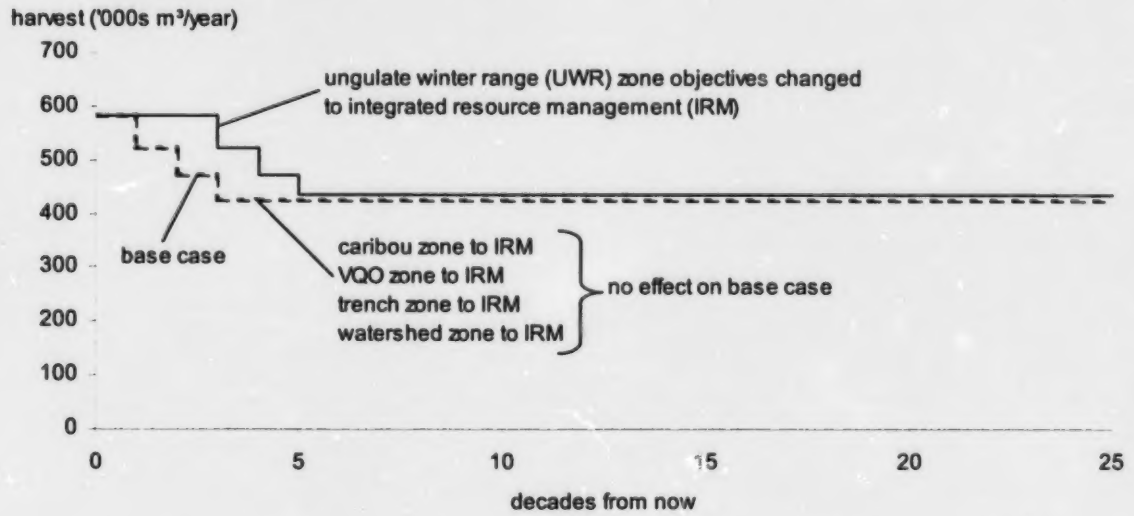


Figure 19. Harvest forecasts resulting when forest cover requirements for each zone are changed to IRM — Invermere TSA, 2000.

5.6 Uncertainty in the estimates of ungulate winter range objectives

Maintaining ungulate winter range is an important wildlife management objective throughout the East Kootenays. Forest cover in winter ranges provides snow interception for elk, white-tailed deer as well as mule deer in the event of severe winter storms. The forest cover objective of a minimum of 40% cover in stands greater than 121 years was established during the late 1980s and 1990s in the Nelson Forest Region. The Ministry of Environment, Lands and Park's ungulate habitat capability mapping completed in the 1980s was recently digitized for this analysis. Figure 20 shows the sensitivity of the timber supply forecast to changes in the per cent cover required, while Figure 21 depicts impacts of changes to the defined age of acceptable snow interception cover.

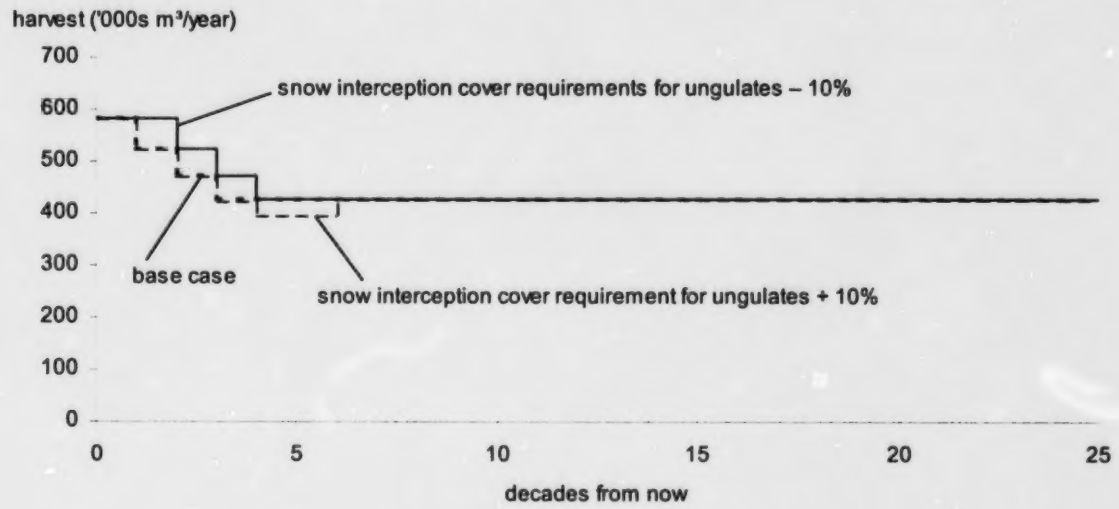


Figure 20. Harvest forecasts showing effects of changes to percentage snow interception cover required — Invermere TSA, 2000.

Decreasing the cover requirement from 40% to 30% in stands older than 121 years allows the current harvest to continue an additional decade before declining parallel to the base case.

Increasing the requirement to 50% pushes the forecast below the base case by 10% for two periods before timber supply can rise to the base case long-term harvest level.

5 Timber Supply Sensitivity Analyses

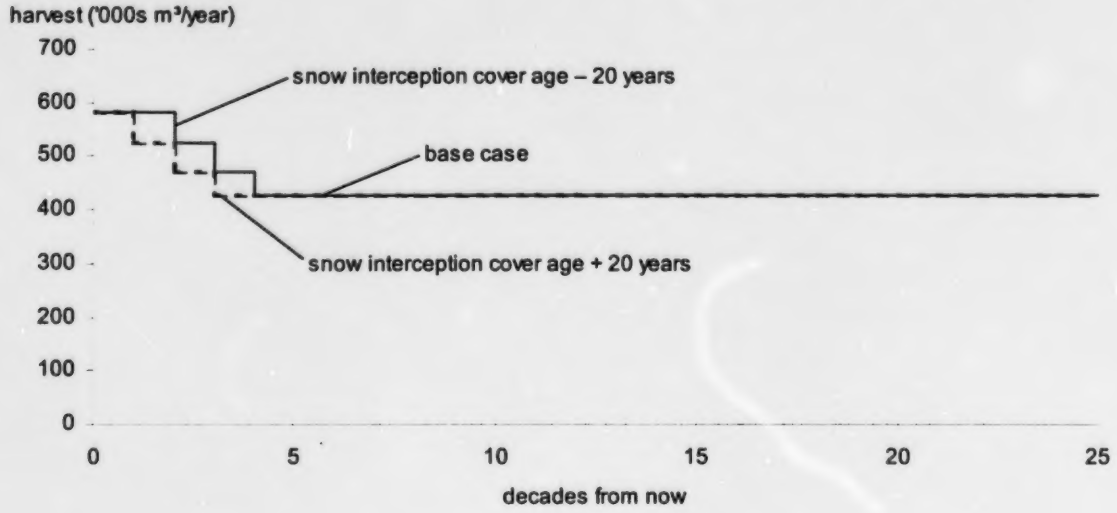


Figure 21. Forecasts showing effects of changes to effective snow interception cover age— Invermere TSA, 2000.

As Figure 21 shows, increasing the minimum age for snow interception cover by 20 years to 141 years has no effect, while a decrease to 101 years allows an additional decade at current harvest and subsequent decline parallel to the base case. Since the changes analysed reflect the approximate levels of uncertainty in the forest cover and age requirements, the results suggest that timber supply is slightly less sensitive to potential changes in snow interception age than in the cover requirement percentage.

5 Timber Supply Sensitivity Analyses

5.7 Uncertainty in the effects of pine harvest priority

Current harvesting priorities in the Invermere Forest District are guided predominantly by the ongoing salvage of pine stands attacked or threatened by mountain pine beetle. For this reason, a priority was put on the pine analysis units* for the first two decades in the model so that pine stands would be chosen for harvest over all other species once all management objectives are met, and given the presence of merchantable pine stands. As pine stands are often not the highest volume stands (and thus require larger areas harvested), their preferential harvest can be expected to cause the area-based forest cover constraints to be approached more quickly than if higher volume per hectare stands were harvested. Figure 22 shows the effects of removing the pine priority, although it should be recognized that the apparent gain in volume would come at a higher risk of increased unsalvaged losses.

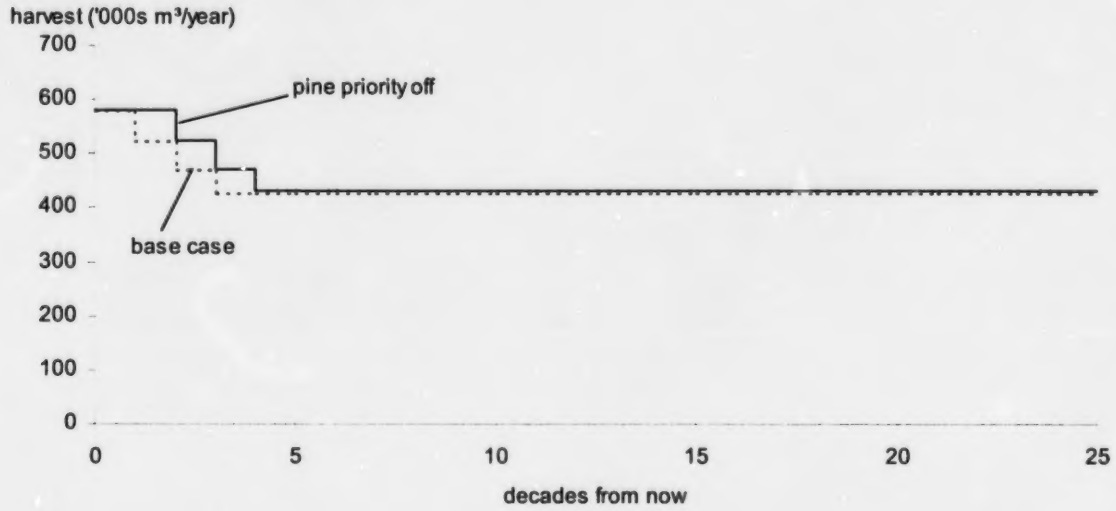


Figure 22. Forecasts showing effect of removing the pine priority — Invermere TSA, 2000.

5.8 Uncertainty in the amount of partial harvesting

Partial harvesting is modelled in this analysis. Partially harvested areas are exempt from all green-up and ungulate winter range cover requirements since it is assumed that retained trees will meet these requirements. Partially harvested stands are also assumed not to meet landscape biodiversity objectives. In this analysis the amount of partial harvesting was limited to a rate equal to that of current operations (22% of current AAC or 46.4% of area harvested). Partial harvest stands were assumed to be 50% removed at time of first entry, and then the remainder harvested 30 years later. Harvesting twice as much area in the short term for a given quantity of wood can be expected to aggravate the area-based mature and old-growth landscape biodiversity objectives in the lower, dryer biogeoclimatic subzones affected. Figure 23 shows three forecasts in addition to the base case, one halving the partial harvested volume, the second allowing the partial harvest to double and the third uncapping the partial harvest entirely.

Analysis unit
A grouping of types of forest - for example, by species, site productivity, silvicultural treatment, age, and or location, done to simplify analysis and generation of timber yield tables.

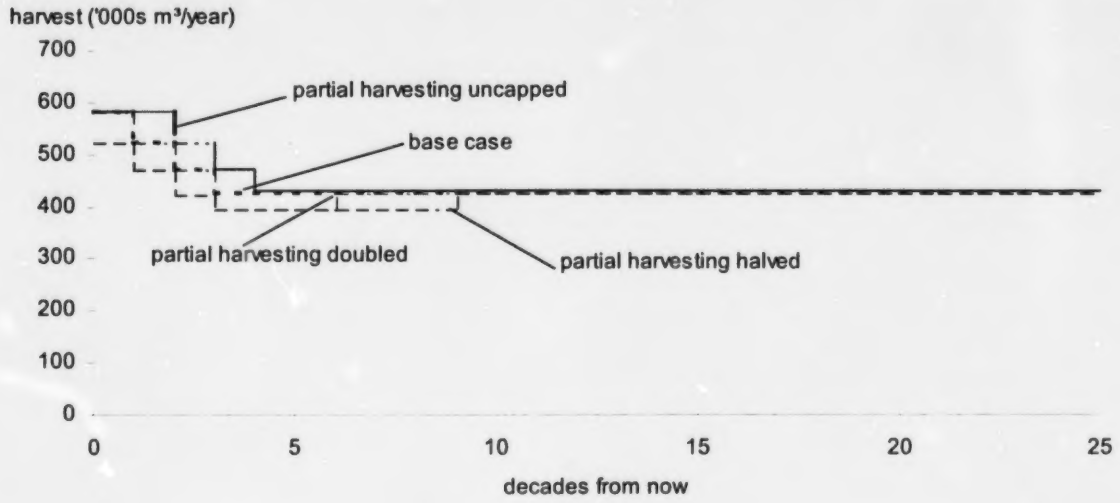


Figure 23. Forecasts showing effects halving, doubling and uncapping the partial harvest — Invermere TSA, 2000.

Halving the partial harvest from 22% of the base case level to 11% reduces the harvest forecast substantially for the first nine decades. Requiring a doubling of the rate of partial harvest to 44% of the current AAC also reduces the forecast substantially between decades four and six. Allowing unlimited partial harvesting to occur, which results in large fluctuations in the amount of partial harvesting from decade to decade, permits an additional decade at the current AAC followed by a decline parallel to the base case.

5.9 Uncertainty in the productivity of current old-growth sites after harvest

The productivity of a site largely determines how quickly trees will grow. It therefore affects the timber volumes in regenerated stands, the time to reach green-up and the age at which stands will reach merchantable size. The most accurate estimates of site productivity come from stands between 30 and 150 years old. At ages less than about 30 years, a temporary increase or decrease in growth due to factors such as a post-harvest flush of nutrients or an unusual drought year can affect the productivity estimated for the stand. At older ages, site productivity estimates may be incorrect because tree heights do not represent actual production — for example due to top breakage — and it is very difficult to determine ages of old trees accurately.

The results of recent province-wide research suggest that the estimated productivity of sites currently occupied by old-growth stands may be significantly underestimated. Two old-growth site index (OGSI) studies applicable to timber supply forecasting are:

- *Site index adjustments for old-growth stands based on paired plots* (Nussbaum 1998). Data were obtained from paired plots installed in old-growth stands and adjacent logged and regenerated stands of the same productivity. Site index was estimated for both and comparisons were made. Results are available for coastal Douglas-fir, lodgepole pine, and interior spruce.
- *Site index adjustments for old-growth stands based on veteran trees* (Nigh 1998). The objective of the study was to develop site index adjustments for species not covered by the paired-plot project. The data for this study came from temporary and permanent plots with a veteran and main stand component. The site indices for the two components were estimated and an adjustment equation for each species was derived using linear regression analysis. The results of the study are considered less reliable than those from the paired-plot study.

5 Timber Supply Sensitivity Analyses

Use of the results of the aforementioned studies is of interest to the Invermere TSA, as stands older than 140 years comprise 19% of the timber harvesting land base. To test the sensitivity of the base case harvest forecast to uncertainty about site index estimates, site indices of these older stands were adjusted using either the paired plot or veteran-tree results, whichever was applicable.

Timber supply analysis inputs affected by changes in estimated future productivity (managed stand volume estimates, green-up ages and minimum harvestable age) were recalculated based on average site productivity. Table 3 compares the average forest inventory-based site index for each old-growth analysis unit to those defined using the OGSI adjustments.

Table 3. Average analysis unit site index based on forest inventory and OGSI information — Invermere TSA, 2000.

Analysis unit	Area (hectares)	Inventory site index	Adjusted site index
Fir/yellow pine good	1 282	17.1	18.8
Fir/yellow pine medium	3 719	15.0	17.2
Fir/yellow pine poor	2 808	11.8	15.9
Larch good	834	20.6	22.1
Larch medium	2 731	16.0	22.1
Larch poor	1 864	10.9	20.2
Spruce/balsam good	2 199	17.5	21.1
Spruce/balsam medium	3 065	15.0	20.2
Spruce/balsam poor	10 376	10.5	19.4
Cedar	235	19.6	18.3
Lodgepole pine–flat good	916	19.2	21.3
Lodgepole pine–steep good	587	19.2	20.6
Lodgepole pine–flat medium	2 137	15.9	19.7
Lodgepole pine–steep medium	2 106	15.9	20.6
Lodgepole pine–flat poor	1 806	11.0	18.5
Lodgepole pine–steep poor	1 492	11.0	18.5
Partial harvest good	654	17.5	19.8
Partial harvest medium	3 425	15.7	17.5
Partial harvest poor	3 776	11.6	15.9

Results of the OGSI sensitivity analysis are presented in Figure 24. The graph shows that the harvest level could be 9.8% higher than the base case during decade 4 and 19.9% higher thereafter. Site index adjustments are not included in the base case since there is little local site productivity data or long-term monitoring of regenerated stands to verify the adjustments.

However, the results of the sensitivity analysis do provide insight into the possible trends associated with site productivity estimates for the Invermere TSA, and indicate that long-term timber supply is likely higher than currently estimated. Note that neither of the studies examined partially harvested stands, thus, the sensitivity analysis may not accurately reflect potential differences for those stands.

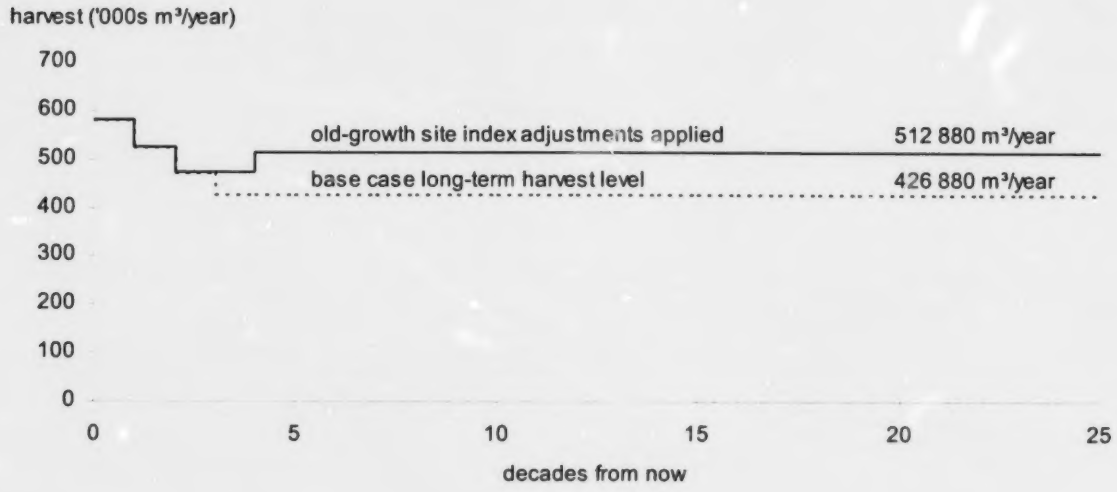


Figure 24. Harvest forecast based on OGSI (paired plot and veteran studies) site index adjustments — Invermere TSA, 2000.

5.10 Uncertainty in the minimum harvestable ages

Minimum harvestable age is the time needed for a stand to reach merchantable condition. The time at which stands will become merchantable is uncertain. This is partly because of uncertainty about the growth of regenerated stands, but more importantly because we cannot foresee future conditions that will determine merchantability.

For this analysis, different criteria were used for defining minimum harvestable ages for existing and regenerated stands. For existing stands, the criteria considered were: minimum volume per hectare, minimum piece size, and achievement of 95% of culmination mean annual increment (MAI). Minimum harvestable age criteria were area-weighted for each analysis unit and a final minimum harvestable age chosen.

For regenerated stands, the criteria used to choose minimum harvestable ages were culmination age*, age at 95% of maximum MAI, as well as site class of specific species. These minimum stand harvest age criteria are described in detail in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." The minimum harvestable ages are not necessarily the actual age of harvest; stands may be harvested at older, but not younger, ages. Most stands are harvested at ages beyond the minimum in order to meet management objectives and forest cover requirements. Minimum harvestable ages are meant to approximate the timing of merchantability, and are not legal or policy requirements.

Culmination age
The age at which a timber stand reaches its highest average growth rate, or mean annual increment (MAI). MAI is calculated as stand volume divided by stand age. Culmination age is the optimal biological rotation age to maximize volume production from a growing site.

5 Timber Supply Sensitivity Analyses

Figure 25 shows how timber supply would change if stands in fact become merchantable either earlier or later than assumed for the base case.

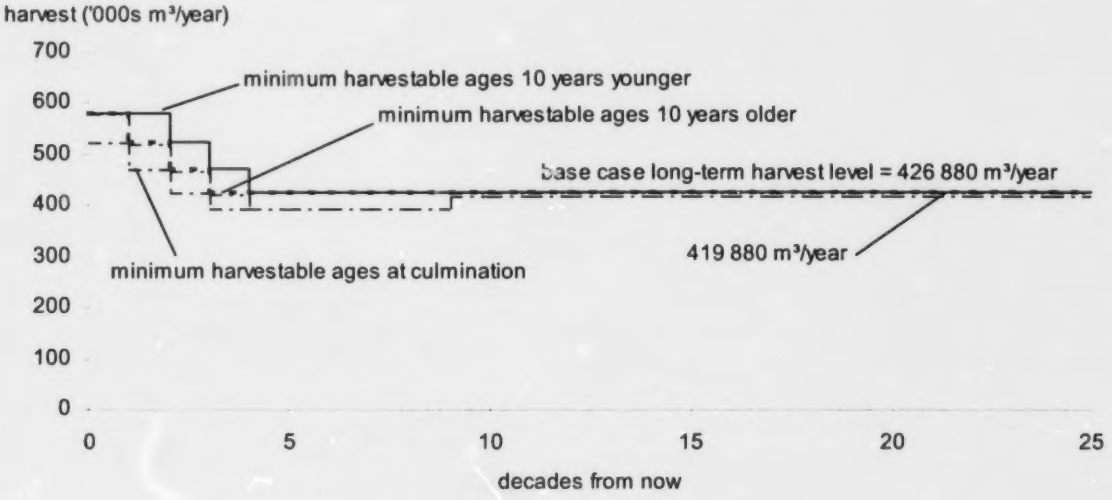


Figure 25. Harvest forecasts if minimum harvestable ages are younger or older than the base case — Invermere TSA, 2000.

If minimum harvestable ages were set 10 years older, results indicate that timber supply would follow the base case for the first four decades, and then reduce to 394 881 cubic metres per year for five more decades before rising to the base case long-term harvest level of 426 881 cubic metres per year.

If minimum harvestable ages were set 10 years younger, the current level of harvest could be maintained for an additional decade and then parallel the base case to the same long-term harvest level of 426 881 cubic metres per year.

Changing the minimum harvestable ages to the culmination age increases the harvestable ages for most analysis units — by as much as four decades in the case of spruce/balsam poor site managed stands. As a result, when existing older stands are unavailable for harvest during the transition period, there are not as many regenerating stands old enough to be harvested under this management regime as there are in the base case. Thus, the harvesting of existing timber must occur at a slower rate to avoid serious timber supply disruptions in the future.

In this analysis, the estimations of minimum harvestable age are not viewed as decisions made to meet forest management objectives, but rather as approximations of the timing of merchantability. This analysis highlights that timber supply is sensitive to uncertainty about this timing. Whether minimum harvestable ages used in the base case are appropriate, optimistic, or pessimistic is largely a matter of opinion. These issues are discussed here because of all variables important to timber supply, minimum harvestable ages are perhaps the most uncertain, at least in areas where most second growth will not be harvested for many years. Many other variables are based on sampling data and experience, or management decisions. Minimum harvestable age, however, will depend on technology and markets well into the future.

5 Timber Supply Sensitivity Analyses

5.11 Alternative harvest queue rules

In the base case, the highest priority for harvest is given to stands that are oldest relative to their minimum harvestable age. This 'relative oldest first' rule is applied only after other requirements and priorities (e.g., forest cover requirements) are taken into account. This rule reflects the practice of favouring older stands, but not necessarily the oldest, for harvest when all other considerations have been met.

Besides the relative oldest first rule, the Forest Service Simulator (FSSIM) model permits use of absolute oldest first, absolute youngest first or random scheduling rules. These other rules may better reflect practices in some instances, given unforeseeable operational constraints that may affect when stands are chosen for harvest. Figure 26 shows how potential harvest levels are affected by changing the way stands are prioritized for harvest.

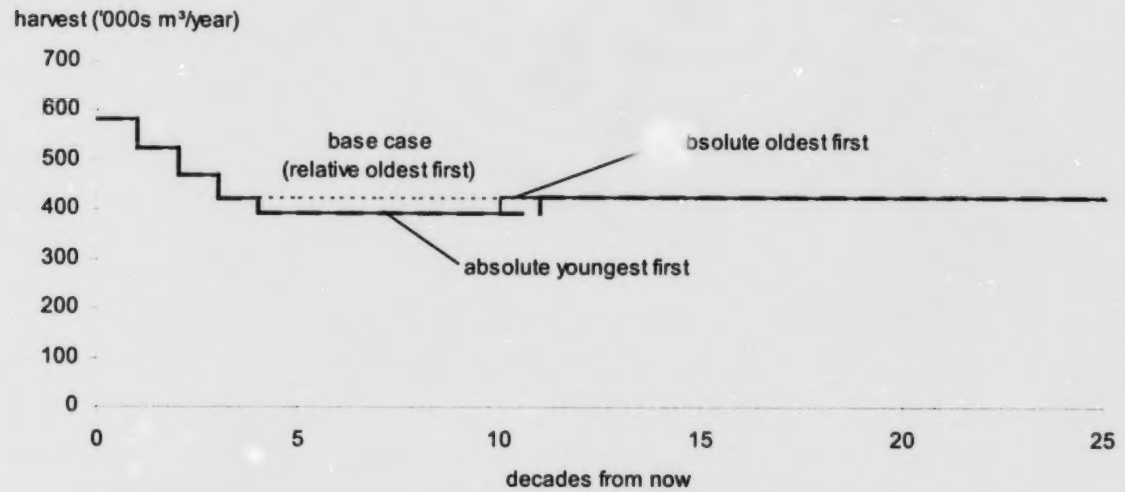


Figure 26. Alternative harvest queue (priority) rules — Invermere TSA, 2000.

The 'absolute youngest first' rule sets the highest priority on stands that have just reached the minimum harvestable age, whereas the 'absolute oldest first' harvest rule schedules all stands above the minimum harvestable age, from oldest to youngest. Both alternatives allow the base case forecast to be maintained for the first four decades, before the harvest level falls below the base case to 394 881 cubic metres per year for five to six decades. It then rises back to the base case long-term harvest level of 426 881 cubic metres per year.

5.12 Uncertainty in the application of landscape-level biodiversity requirements

As described in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis," prescriptions for maintaining biodiversity at both the stand and the landscape levels were modelled in the base case. Stand-level biodiversity was addressed in this analysis by reducing the timber yield from the various species groups (analysis units). Uncertainty about stand-level biodiversity can be assessed through sensitivity analyses that examine the timber supply impacts of yield predictions, as discussed in Sections 5.3, "Uncertainty in estimated existing stand yields" and 5.4, "Uncertainty in estimated managed stand yields."

Landscape-level biodiversity, however, was modelled in this analysis by applying forest cover requirements to biogeoclimatic subzones and variants within each landscape unit. There is some uncertainty about how the recommendations in the *Landscape Unit Planning Guide* will be applied operationally. The following sensitivity analyses provide an indication of the risk associated with uncertainty about management for landscape-level biodiversity.

5 Timber Supply Sensitivity Analyses

Management for landscape-level biodiversity in the Invermere TSA includes provision for the maintenance of mature forest as well as old-growth forest specific to the biodiversity emphasis option (BEO) agreed to with the Ministry of Environment, Lands and Parks and assigned each landscape unit in the forest district. These BEOs are being managed for presently, and legal establishment is imminent.

An analysis testing the effects of the base case landscape unit-specific BEOs shows no impacts relative to provincially-adopted blended targets which assumed the proportions of the land base subject to lower, intermediate and higher BEOs will be 45%, 45%, and 10% respectively in each individual landscape unit/BEC sub zone area. Another analysis of the effects of immediately applying the full seral requirement for old growth in low emphasis landscape units *versus* the gradual phase in over three rotations also showed no change.

Figure 27 illustrates the effect of increasing and decreasing the mature- and old-growth forest cover requirement percentages by 10%. Increasing the cover requirement percentages by 10% forces the forecast below that of the base case from decade 5 to 9 to 394 881 cubic metres before timber supply rises to the long-term harvest level.

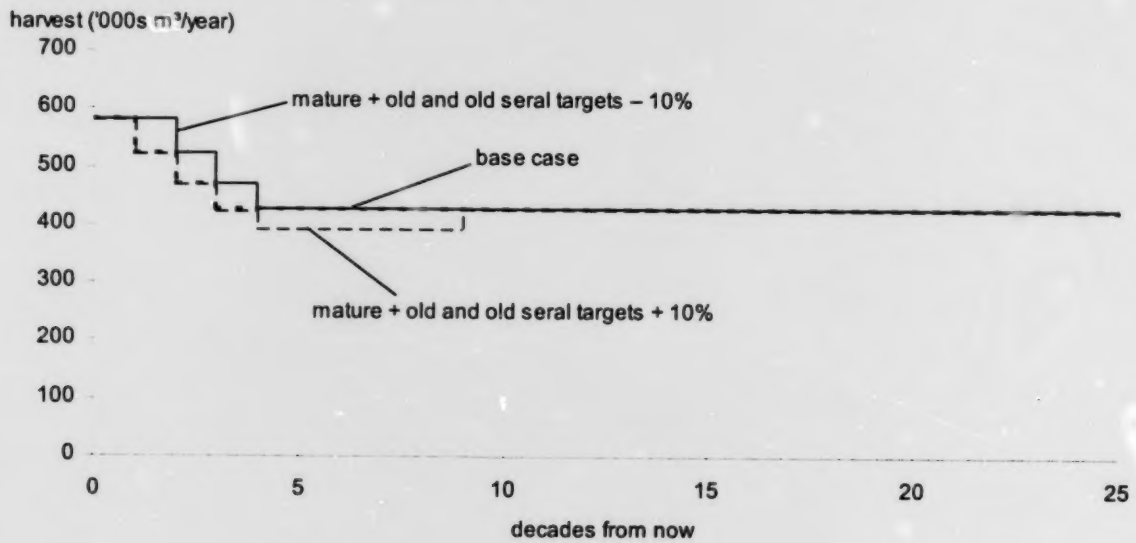


Figure 27. Harvest forecasts if landscape-level biodiversity mature and old seral percentage requirements are changed — Invermere TSA, 2000.*

Old seral
Old seral refers to forests with appropriate old forest attributes which provide for biodiversity. Ages vary depending on biogeoclimatic variant and are specified in the Landscape Unit Planning Guide.

5 Timber Supply Sensitivity Analyses

Increasing the age thresholds of mature forest as well as old-growth forest by 20 years had no effect, while reducing them allowed the current AAC to be maintained for one additional decade, followed by a decline parallel to the base case to the same long-term harvest level, as Figure 28 depicts.

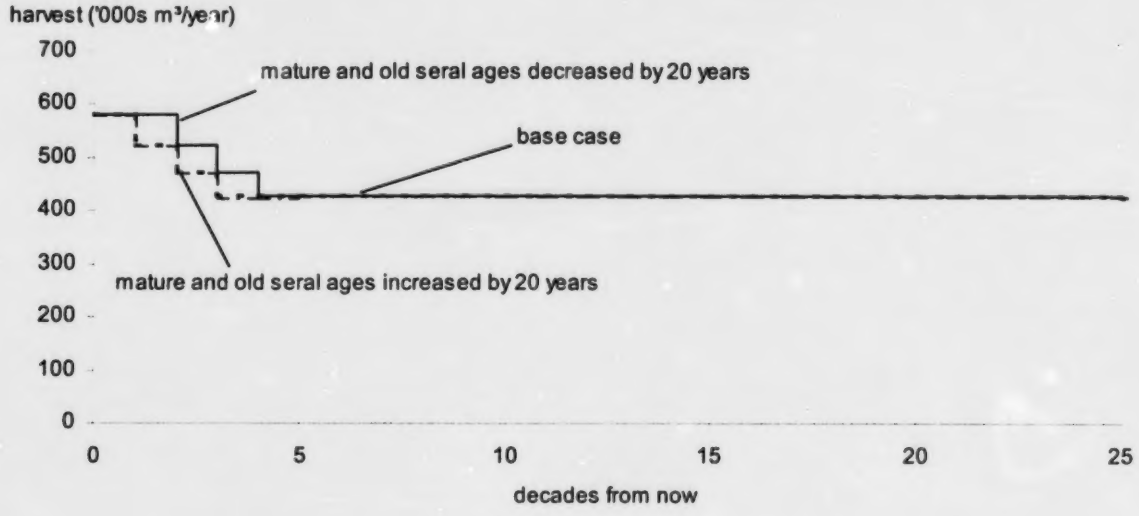


Figure 28. Harvest forecasts if landscape-level biodiversity age assumptions are changed — Invermere TSA, 2000.

6 Summary and Conclusion of the Timber Supply Analysis

The results of this timber supply analysis suggest that the current Invermere TSA allowable harvest level of 581 570 cubic metres per year (which excludes 9930 cubic metres allocated to woodlot licences) can be maintained for up to ten years without requiring substantial and rapid future harvest level reductions, or creating severe future timber supply disruptions. Using current inventory and timber growth information and assuming continuation of current forest management practices, harvests could be maintained at the current level for ten years, if followed by a decline of 10% per decade for the following three decades to a long-term harvest level of 426 881 cubic metres per year.

The base case results reflect current knowledge and information on forest inventory, growth and yield, and management. However, uncertainties about several factors important in defining timber supply affect the harvest flow to varying degrees.

Short-term timber supply is sensitive to changes that influence the amount of timber available from existing unmanaged stands because the harvest forecast relies on these stands for the next 90 years. In particular, any reductions in estimates of timber volumes in existing stands or in the size of the timber harvesting land base could have negative effects on harvest flow over the short term (next 20 years). An audit conducted in 1997 showed that the inventory estimates of volume for mature stands (over 60 years old) on the operable land base are not statistically different from volumes derived using ground measurements. The audit therefore suggests that the inventory reasonably portrays the standing timber volume in existing stands at the TSA level.

Medium-term (21 to 80 years from now) timber supply is affected by estimates of forest cover requirements for management of ungulate winter range, and the rule used to set priorities for harvest scheduling, as well as the factors affecting short-term timber supply mentioned above.

Long-term timber supply is affected by uncertainties in the management requirements for landscape-level biodiversity, estimates of regenerated stand yields, estimates of site productivity for old-growth stands, and the availability of seeds from seed orchards.

In conclusion, this analysis indicates that based on current inventory and growth and yield information, and the current management practices, timber harvesting in the Invermere TSA can be maintained at the current level of 581 570 cubic metres for the next ten years. Following that period, the harvest would likely need to reduce over a period of 20 years to a long-term harvest level of 426 880 cubic metres. The analysis indicates that several factors related to the current forest inventory and management regime could affect timber supply. The factor most likely to affect the timber supply projected in the base case would be new information supporting higher site index estimates for regenerating stands which could result in an increase in long-term harvest. For change in other factors, there does not appear to be a high sensitivity or effect on harvest flow.

7 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the Timber Supply Review. The socio-economic analysis compares the level of forestry activity currently supported by timber harvested from the Invermere TSA to the level of activity that could be expected given the timber supply projected in the base case harvest forecast.

The socio-economic analysis uses the base case harvest forecast as an indication of timber supply levels but does not examine alternative management scenarios.

The socio-economic analysis includes:

- a profile of the current socio-economic setting;
- a description of the Invermere TSA forest industry; and,
- an analysis of the socio-economic implications of the base case harvest forecast.

7.1 Current socio-economic setting

7.1.1 Current population and demographic trends

The Invermere TSA is one of seven TSAs in the Nelson Forest Region and has a population of approximately 9,230 people (1996 Census). The major communities are Invermere, Windermere, Canal Flats and Edgewater, with a combined population of more than 5,000. Smaller communities include Fairmont Hot Springs, Radium Hot Springs and Wilmer. Between 1991 – 1996, the population of the TSA increased by more than 26% or more than 5% annually. By 2001, the population of the TSA is projected to be 10,200, an increase of about 10.5% from 1996.

Table 4. Population statistics, Invermere TSA, 1991-2001

Communities	Population 1991 census	Population 1996 census	Population 2001 estimate	Estimated per cent change 1996-2001
Canal Flats	685	753	872	15.8
Edgewater	518	588	671	14.1
Fairmont Hot Springs	249	364	372	2.2
Invermere	2,207	2,687	2,968	10.5
Radium Hot Springs	395	530	561	5.8
Wilmer	350	372	438	17.7
Windermere	821	977	1,090	11.6
Other communities	2,072	2,956	3,225	9.1
Invermere TSA	7,297	9,227	10,197	10.5

Source: 1991 and 1996 Census data.

Estimates are based on Local Health Area Population Projections. Data are from Population Section, BCSTATS.

7.1.2 Economic profile

From 1991 to 1996, the experienced labour force in the Invermere TSA increased by 28% to 5,075. In comparison, the experienced labour force for the province increased by almost 24% over the same period. The unemployment rate in the Invermere TSA was 10.5% in 1996, compared with 8.2% in 1991. As Figure 29 illustrates, the major employment sectors in the Invermere TSA are tourism, forestry, and the public sector (which includes education, health, and federal, provincial and local public services). Figures from the 1996 Census indicate that the forest sector accounted for approximately 20% of employment in the TSA.

Tourism, which includes portions of several service sectors including accommodation services, retail trade and transportation, has demonstrated significant growth and investment in recent years. Almost 1,700 persons are employed in the Invermere TSA's tourism sector, catering to both tourist and business travellers. Nearly 200 businesses in the Invermere TSA service visitors' needs, including outdoor recreation facilities, tours and attractions, retail and service businesses, food and beverage facilities, and accommodations.

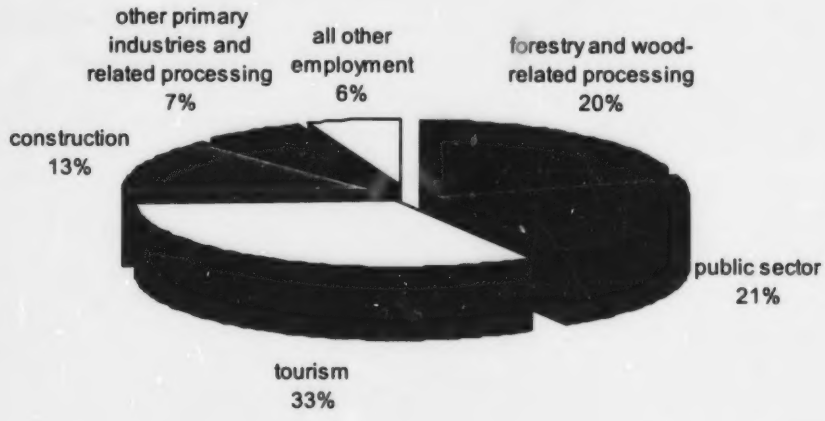


Figure 29. Estimates of total employment by sector, Invermere TSA, 1996.

Source: B.C. Ministry of Finance and Corporation. The 1996 Forest District Tables.

Income, whether business or personal, is another indicator of a sector's contribution to the economy. Jobs in sectors with high-income levels tend to support more employment per job than those in sectors with lower income levels.
Statistics Canada labour force data, comparing average weekly earnings in different sectors of the economy, indicate that the forest sector is one of the highest paying sectors and, therefore, a major contributor to the local and provincial economies. Mining is the only sector that has consistently paid higher wages than forestry. In 1999, the average weekly earnings (before income taxes) in the forest sector were approximately $935, compared to $1,165 for the mining sector. Other sectors' average weekly earnings were: $697 for the construction industry; $244 for the accommodation, food and beverage services industries; and $797 for the public sector.

7 Socio-Economic Analysis

Employment multipliers reflect the income effect: the greater the multiplier, the greater the impact that each job in this sector has on the economy. For example, estimates by the Ministry of Finance and Corporate Relations indicate that for every 100 full-time direct forestry jobs in the Invermere TSA, another 23 to 63 indirect and induced jobs are supported, depending on the forestry activity (harvesting or timber processing). In comparison, for every 100 full-time direct jobs in the tourism sector, an estimated additional seven to 14 indirect and induced jobs are supported. The differences are a result of greater spending patterns by both forest sector businesses and their employees. Table 5 compares estimated employment, average weekly earnings and employment multipliers for selected sectors of the Invermere TSA's economy.

Table 5. Average weekly earnings and employment multipliers, Invermere TSA.

Basic industry sector	Average weekly earnings in 1999 ($/week)	Employment multiplier[a]
Forestry and related jobs	935.00	1.23 - 1.63
Mining and related jobs	1,165.00	1.37 - 1.50
Construction	697.00	1.25 - 1.33
Tourism	244.00	1.07 - 1.14
Public sector	797.00	1.11 - 1.19

(a) Includes direct, indirect and induced jobs.

Sources: Statistics Canada, *Estimates of Average Weekly Earnings*. 1999. (Weekly earnings are before income taxes).
Ministry of Finance and Corporate Relations, *The 1996 Forest District Tables*, April, 1999.

7.2 Invermere TSA forest industry

7.2.1 Current allowable annual cut

The current allowable annual cut (AAC) for the Invermere TSA is 591 500 cubic metres. This level was set in 1996 and was a decrease of 59 500 cubic metres from the previous harvest level. Forest licences account for nearly 84% of the apportioned volume in the TSA, and the Ministry of Forests' Small Business Forest Enterprise Program (SBFEP) accounts for about 10% of the apportioned volume. Table 6 indicates the current apportioned allowable annual cut by type of licence.

Table 6. Allowable annual cut apportionment by licence type, Invermere TSA.

Type of licence	AAC (cubic metres per year)	Per cent (%) of AAC
Forest licences, replaceable	494 848	83.7
Timber sale licence (TSL) > 10 000 m³, replaceable	0	0.0
TSL < 10 000 m³, replaceable	10 673	1.8
Small Business Forest Enterprise Program (SBFEP)	74 049	9.5
Forest Service Reserve	2 000	0.3
Woodlot licences	9 930	1.7
Total	591 500	100.0

Source: Ministry of Forests, Resource Tenures and Engineering Branch.

7.2.2 Invermere TSA recent harvest history

The actual annual harvest level is an important indicator of forestry activity in the TSA. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year determines the level of economic activity.[1] If actual annual harvest levels are less than the AAC, then economic activity is less than the TSA's full potential. A persistent gap between the AAC and the actual annual harvest level could influence the potential short-term impacts of changes in the AAC.

Table 7 summarizes the volume of timber harvested in the Invermere TSA from 1995 to 1999. Based on the past five years' average, the annual average harvest volume for the TSA has been close to the apportioned volume.

(1) Cut control permits licensees to vary the volume between annual harvest and AAC by +/– 50% per year and by +/– 10% over a 5-year period. This variability gives licensees the flexibility to adapt to changing conditions, including changing market conditions.

Table 7. Volume billed by licence type, Invermere TSA, 1995-1999.

Type of licence[a]	(cubic metres) 1995	1996	1997	1998	1999	Average 1995-1999
Forest Licence	478 912	637 569	420 017	440 748	577 928	511 035
Small Business Forest Enterprise Program (SBFEP)[b]	78 055	98 237	92 399	112 971	108 314	97 995
Total[c]	556 967	735 806	512 416	553 719	686 242	609 030
AAC	657 264	591 500	591 500	591 500	591 500	

Source: Ministry of Forests, Harvest Database and Invermere Forest District data.

(a) Timber harvested from private lands and woodlots are not included in the analysis of this report. Average annual harvest from private lands for the same period was 35 741 cubic metres and from woodlots was 21 386 cubic metres.

(b) Includes TSLs < 10 000 m^3/year and cutting permits such as rights-of-way clearing, roads, beach comb, trespass and other miscellaneous harvests.

(c) For 1997-1999, a carry-forward of volume of 24 479 m^3 was not included.

7.2.3 Invermere TSA major licensees and processing facilities

Crestbrook Forest Industries Ltd. (Crestbrook)

Crestbrook has a replaceable forest licence to harvest 263 843 cubic metres per year, a decrease of about 26 830 cubic metres per year from the previous harvest level. Almost all the harvest from this licence is processed at the company's lumber mill in Canal Flats. As Table 8 shows, based on 1997 – 1999 data, Crestbrook's average annual harvest from this licence supported an estimated 239 – 269 person-years of employment in harvesting, silviculture, timber processing and related activities. Close to 70% of the workers associated with the harvesting and processing of the timber from this licence reside in the Invermere TSA.

Table 8. Crestbrook's billed volumes and provincial employment statistics

Allowable annual cut	
Forest Licence A18978	263 843 cubic metres
1997-1999 average annual volumes billed	279 466 cubic metres
1999 volumes billed	319 891 cubic metres
Estimated employment[a] — person-years	
Harvesting and administration	118-128
Log transport	(included with harvesting)
Road construction and maintenance	7
Silviculture	10-13
Timber processing	104-121
Total person-years	239-269

Source: Ministry of Forests, Harvest Database.

(a) Based on 1997-1999 average annual harvest of 279 466 cubic metres. Estimates of employment are derived from information supplied by the licensee and include employment associated with TSA timber which is processed outside the TSA.

Slocan Forest Products Ltd. (Slocan)

Slocan has a replaceable forest licence to harvest 231 005 cubic metres per year, 23 491 cubic metres per year less than the previous harvest level. More than 50% of harvested timber from this licence is processed in the company's lumber mill in Radium Hot Springs. Based on 1997 – 1999 data, Slocan's average annual harvest from this licence supported an estimated 278 – 302 person-years of employment in harvesting, silviculture, timber processing and related activities, as shown in Table 9. Approximately 50% of the workers associated with the harvesting and processing of the timber from this licence live in the Invermere TSA.

Table 9. Slocan's billed volumes and provincial employment statistics

Allowable annual cut	
Forest Licence A 18979	231 005 cubic metres
1997-1999 average annual volumes billed	227 575 cubic metres
1999 volumes billed	285 516 cubic metres
Estimated employment[a] — person-years	
Harvesting and administration	71-77
Log transport	12
Road construction and maintenance	7
Silviculture	8-12
Timber processing	180-194
Total person-years	278-302

Source: Ministry of Forests, Harvest Database.

(a) Based on 1997-1999 average annual harvest of 227 575 cubic metres. Estimates of employment are derived from information supplied by the licensee and include employment associated with TSA timber which is processed outside the TSA.

Small Business Forest Enterprise Program (SBFEP) and **Timber sale licenses** (TSLs).

The apportioned harvest volume in Invermere TSA's SBFEP is 74 049 cubic metres per year, or about 10% of the TSA's total allowable annual cut. In addition, there are there are three TSLs in the Invermere TSA issued to North Star Planing Co. Ltd., John Soles and Clarence Palumbo. The combined volume of these licences is 10 673 cubic metres per year. SBFEP and TSL harvests in recent years have averaged more than 100 000 cubic metres per year, or about 14% of the total harvest in the TSA. An estimated 75% of the timber harvested by SBFEP and TSL operators is processed within the TSA. As shown in Table 10, based on averages of licensees and operators in the TSA, the volume harvested supported an estimated 104–122 person–years of employment in harvesting, silviculture, timber processing and related activities. An estimated 70% of the timber is harvested by SBFEP and TSL operators who reside within the Invermere TSA.

Table 10. SBFEP and TSL — billed volumes and provincial employment statistics.

Allowable annual cut	80 722 cubic metres
Annual average harvest (1997-1999)	104 561 cubic metres
1999 harvest	108 314 cubic metres
Estimated employment[a] — person-years	
Harvesting and administration	38-44
Log transport	2-3
Road construction and maintenance	3
Silviculture	4-5
Timber processing	57-67
Total person-years	104-122

Source: Ministry of Forests, Harvest Database.

(a) Based on 1997-1999 annual average harvest of 104 561 cubic metres. Estimates of employment are derived from industry averages of licensees and operators in the TSA and include employment associated with TSA timber which is processed outside the TSA.

Invermere TSA timber supply and processing capacity

Nearly 80% of the timber harvested in the Invermere TSA is processed within the TSA. Timber processing facilities include seven lumber mills, one pole plant and a pulp mill. These facilities have an estimated annual processing capacity of approximately 1.2 million cubic metres. Between 1997 and 1999, harvests in the TSA averaged approximately 584 126 cubic metres per year. Additional timber supply to mills in the TSA comes from nearby TSAs, TFLs as well as private sources, see Table 11.

Table 11. Timber processing facilities and estimated annual capacities, Invermere TSA, 1999

Processor	Type of mill	Location	Estimated annual capacity ('000s m³/year)
Brisco Wood Preservers Ltd.	Pole	Brisco	15
Clarence Palumbo Sawmills Ltd.	Lumber	Parson	25
Crestbrook Forest Industries Ltd.	Lumber	Canal Flats	600
Mardis Forest Products Ltd.	Lumber	Skookumchuk	30
North Star Planing Co. Ltd.	Lumber	Athalmer	25
Seel Forest Products Ltd.	Lumber	Edgewater	80
Slocan Forest Products Ltd	Lumber	Radium Hot Springs	425
Ukass Logging Ltd.	Lumber	Wilmer Creek	30
Total timber volume			1 230
Crestbrook Forest Industries Ltd.	Pulp	Skookumchuk	460[a]
Total pulp fibre volume			460[a]

Source: Ministry of Forests, Major Primary Timber Processing Facilities in British Columbia, 1999.

(a) The unit of measurement for fibre input to pulp mill is thousands of bone dry units (000 BDU).

7.2.4 Forest sector employment and employment coefficients

The preceding harvesting and employment information is used to develop employment coefficients which are used to project future employment levels in the forest sector. For this purpose, the forest sector has been divided into three sub-sectors:

- harvesting and other woodlands-related employment such as falling, log transportation, log salvage, log scaling, and harvest planning and administration;
- silviculture employment such as planting, surveying, and other basic and intensive silviculture activities, such as spacing, fertilizing and pruning*; and,
- primary timber processing employment, such as manufacturing activities at lumber mills, veneer and plywood mills, shake and shingle mills and pulp and paper mills.

Pruning
The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

Harvesting employment

The harvesting employment component is very closely related to the volume that is harvested and is, therefore, the first sub-sector affected by changes in the TSA's harvest level. This sub-sector includes employees who work in the harvesting operations of a forest company as well as those who work as contract loggers. Harvesting activity in the Invermere TSA occurs mostly between May until the following March. Cable and ground-based harvesting systems are the main types of harvesting methods used. In recent years, there has been an increase in the volume of timber harvested by innovative means such as helicopter logging, especially in environmentally sensitive areas.

Silviculture employment

The silviculture employment component is not as closely related to the AAC because an amount of time can elapse between when harvesting takes place and when replanting the harvested areas begins[2]. Basic silviculture consists of surveys, site preparation, planting, brushing, cone collection and spacing. Enhanced silviculture includes spacing, fertilization and pruning. In the Invermere TSA, licensees are responsible for basic silviculture on areas harvested under major licences; the provincial government is responsible for enhanced silviculture and the remaining basic silviculture on Crown land.

Primary timber processing employment

The timber harvested from the Invermere TSA is processed into a variety of products such as lumber, panel products, log homes, poles and posts, shakes and shingles, and pulp and paper at mills within the TSA and in neighbouring TSAs. Mills in the TSA also process timber which is harvested from other TSAs and private sources.

Ministry of Forests employment

Approximately 50 to 55 people work in the Invermere Forest District office. District staff oversee the management of forestry-related activities on Crown land in the Invermere TSA. Employment in the Ministry of Forests is not included as part of direct employment in the forest sector because their activities are more related to administration and enforcement of government policy rather than to the timber harvest and would not be affected by marginal changes in the timber supply. Ministry employees are, nevertheless, an important component of total employment in the TSA and are included in the government services component of the TSA's economic base.

Employment coefficients

Employment coefficients, expressed as person-years of employment per 1000 cubic metres of harvest, have been calculated using employment information from licensees and operators. Table 12 summarizes employment supported by the 1997 – 1999 harvests in the Invermere TSA and the corresponding employment coefficients. The coefficients have been calculated at the TSA and provincial level to highlight the importance of the forest sector within the Invermere TSA and to identify the contribution it makes to the provincial economy. The employment and coefficients are reported at two levels as follows:

1) TSA employment and employment coefficients, which comprise of residents of the Invermere TSA who are employed in the forest sector within the Invermere TSA; and,

2) provincial employment and employment coefficients, which comprise all forest sector employment in the province that relies on the Invermere TSA timber supply, including both residents of the Invermere TSA and those who live elsewhere.

(2) In addition to replanting the harvested area, there are requirements for the harvested stand to be re-established, first to a green-up state and then to a free-to-grow state. The time that it takes for a replanted area to reach green-up state varies, depending on the requirements for visual, hydrological and wildlife resource values. The height requirement for replanted stands can vary among different resource zones. The time required for the replanted stands to reach the free-to-grow state (when the planted commercial species are as high or higher than competing non-commercial species or brush vegetation) varies according to the silviculture system being used and the ecological association of the stand. Previous experiences indicate that this time period can range from 7 to 20 years after harvest. Silviculture activity in harvested areas continues until the stands reaches the free-to-grow state.

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Employment is divided into direct, indirect and induced components; the sum of the components is the total impact, expressed as the number of full-time jobs per 1000 cubic metres of timber harvested or processed. Indirect and induced employment figures were derived using employment multipliers developed by the Ministry of Finance and Corporate Relations.

The 1995 *Invermere Timber Supply Area Socio-Economic Analysis* indicated that the previous AAC of 657 264 cubic metres supported an estimated 572 person-years of direct employment in the province; indicating a provincial employment coefficient of 0.88 person-years of direct employment per 1000 cubic metres. The current timber supply review indicates that harvesting, silviculture and timber processing activities associated with Invermere TSA's 1997 – 1999 average annual harvest of approximately 584 126 cubic metres, supported an estimated 616 person-years of direct employment in the province, indicating a provincial employment coefficient of 1.05 person-years of direct employment per 1000 cubic metres[3]. A more detailed discussion regarding employment coefficients is presented in Appendix B, "Socio-Economic Analysis Background Information."

Table 12. Forest sector employment and employment coefficients, Invermere TSA, 1997-1999

Forest industry activity	TSA employment (person-years)	TSA coefficients (person-years / '000s m³)	Province employment (person-years)	Province coefficients (person-years / '000s m³)
Harvesting	221	0.38	242	0.41
Silviculture	10	0.02	23	0.04
Timber processing	121	0.21	351[a]	0.60
Total — direct	352	0.60	615	1.05
Total — indirect + induced	127	0.22	678	1.16
Total employment	479	0.82	1,294	2.21

Note: Employment estimates are reported in person-years based on 1997-1999 average employment levels and average harvest level of 584 126 cubic metres in the Invermere TSA. Due to rounding, some totals may not equal the sum of their components.

(a) Although the Skookumchuk pulp mill is located within Invermere TSA boundaries, almost all the employees who work there live outside the TSA.

(3) Differences in employment coefficient ratios can be due to several reasons: 1) different sources of information; 2) different methods of calculations; 3) reference to employment at different harvest levels; 4) different definitions of full time employment; and 5) different definitions of forestry sub-sectors. Whichever definitions are used, however, the resulting estimates of impacts of harvest level changes should illustrate similar effects.

7.2.5 Invermere TSA forest sector employment income

In 1999, the average annual income of forestry employees was: $46,956 for those working in logging and forestry services; $44,980 for those working in solid wood manufacturing; and $58,136 for those working in pulp and paper mills. For those engaged in indirect and induced employment (such as construction, business services, retail trade, etc.) the estimated average annual income in 1999 was $30,732. Based on 1997 – 1999 annual averages, the Invermere TSA's timber harvest supported approximately $29.20 million in direct employment income and an additional $20.56 million of indirect and induced employment income. In all, the harvest supported an estimated total of $49.76 million in employment income, or more than $85,000 per 1000 cubic metres harvested.

Table 13. Average forest sector provincial employment income

Employment component	Estimated person-years	Estimated annual wage ($)	Total income ($millions)	Income per '000s m^3 of wood ($ / '000s m^3)
Direct employment				
Logging and forestry	265	46,844	12.41	21,252
Solid wood processing	292	46,183	13.49	23,087
Pulp and paper processing	59	55,931	3.30	5,649
Subtotal	616		29.20	49,988
Indirect/induced employment	678	30,320	20.56	35,193
Total	1,294		49.76	85,180

Source: Statistics Canada. *Survey of Employment, Payroll and Hours* 1997 to 1999, and based on 1997 to 1999 average annual harvest of 584 126 cubic metres) data. Due to rounding, some totals may not equal the sum of their components

7.2.6 Provincial government revenues

The provincial government receives taxes and revenues from the forest industry. The forest industry pays stumpage, royalties and rent to the provincial government for the right to harvest and use timber. The forest industry also pays operating taxes such as logging tax, corporate income tax, property and sales taxes. As well, the provincial and federal governments receive revenues from forestry employees through income taxes.

Between 1997 and 1999, the timber harvest in the Invermere TSA contributed approximately $10.157 million in stumpage and rent payments annually to the provincial government. Other taxes paid by the forest industry, such as logging tax, corporate income, property and sales taxes, contributed approximately $4.538 million annually. In addition, the provincial government received approximately $4.297 million in income taxes paid by forest sector employees. Altogether, the timber harvest in the Invermere TSA contributed an estimated $18.992 million to provincial government revenues.

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Table 14. Average annual provincial revenues, Invermere TSA, 1997 – 1999

(based on annual average volume harvested of 584 126 cubic metres per year)

Provincial revenues sources	Average annual provincial revenues ($ million)	Average annual provincial revenue per '000s m³ of wood ($/'000s m³)
Stumpage and related revenues[a]	10.157	17,388
Forest industry taxes[b]	4.538	7,769
Employment income taxes[c]	4.297	7,356
Total provincial revenues	18.992	32,513

(a) Ministry of Forests, Revenue Branch.

(b) Based on estimates by PriceWaterhouseCoopers, and includes taxes for logging, corporate income, corporate capital, sales, property and electricity.

(c) Estimated from Revenue Canada income tax rates and includes only the provincial share of income taxes paid.

7.3 Socio-economic implications of the base case harvest forecast

The socio-economic analysis focuses on harvest level changes in the short- to medium- term of 10 to 30 years from now and considers:

- the implications of alternative harvest levels for both the Invermere TSA and the province;
- possible impacts on the communities within the TSA;
- timber requirements of processing facilities within the Invermere TSA; and
- regional timber supply implications.

The socio-economic analysis considers average levels of forestry activity that the base case harvest forecast could support, assuming that the current role of the forestry sector in the provincial economy continues and that labour productivity does not change. The analysis also assumes that the proportions of harvesting, silviculture and timber processing employment remain constant and that the types and portions of wood products manufactured remain the same.

Employment impacts associated with future harvest levels are calculated using employment coefficients (person-years of employment per 1000 cubic metres). This method of calculating employment coefficients assumes that employment levels in the future can be predicted using current conditions of employment and the volume of timber harvested or processed. While this method can be reasonably accurate for short-term forecasts (within the next three to five years), employment coefficients 20 years from now may be very different due to changes in forest products market conditions, timber processing technologies, etc. The analysis provides an indication of the magnitude of impacts on employment, employment income and provincial government revenues, within a constantly changing socio-economic environment.

7.3.1 Employment and employment income impacts within the Invermere TSA

Using 1997 – 1999 annual averages, the base case harvest forecast of 581 570 cubic metres per year for the first decade, will support an estimated 477 person-years of employment (direct, indirect and induced) in the TSA. Employment will tend to fluctuate around this level as companies respond to market changes and adjust harvesting activities under cut control regulations. Employment income generated in the Invermere TSA is estimated to be $20.1 million.

In the second decade, the base case harvest forecast is 523 413 cubic metres per year. This harvest volume will support an estimated 429 person-years of employment (direct, indirect and induced in the TSA). Employment income generated by the harvest volume is estimated to be $18.1 million.

In the third decade, the base case harvest forecast is 471 071 cubic metres per year. This harvest volume will support an estimated 386 person-years of employment (direct, indirect and induced in the TSA). Employment income generated by the harvest volume is estimated to be $16.3 million.

In the fourth and subsequent decades, the base case harvest forecast is 426 881 cubic metres per year. This harvest volume will support an estimated 350 person-years of employment (direct, indirect and induced in the TSA). Employment income generated by the harvest volume is estimated to be $14.8 million.

7.3.2 Employment and employment income impacts in the province

Provincial employment includes all forest sector employment supported by the timber harvested from the Invermere TSA. In the first decade as shown in Table 15, the base case harvest forecast will support an estimated 1,288 person-years of employment in the province and generate an estimated $49.5 million in employment income.

In the second decade, the base case harvest forecast will support an estimated 1,159 person-years of employment and generate an estimated $44.6 million per year in employment income. In the third decade, the base case harvest forecast will support an estimated 1,043 person-years of employment and generate an estimated $40.12 million per year in employment income. In the fourth and subsequent decades, the base case harvest forecast will support an estimated 946 person-years of employment and generate an estimated $36.4 million per year in employment income.

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Table 15. Invermere TSA socio-economic impacts: base case harvest forecast

	At current AAC[a]	Base case harvest forecast			
		Decade 1	Decade 2	Decade 3	Decade 4 and subsequent decades
Harvesting activity			(cubic metres)		
Timber supply	591 500	581 570	523 400	471 100	426 900
Harvest level (1997-1999 average)	584 126	N/A	N/A	N/A	N/A
Difference from current AAC	7 374	9 930	68 100	120 400	164 600
Invermere Timber Supply Area					
Employment			(person-years)		
Direct	357	351	316	284	257
Indirect/induced	129	126	114	102	93
Total	485	477	429	386	350
Range of employment gain[b] or loss		(7 – 8)	(51 – 56)	(90 – 99)	(123 – 135)
Employment income			($ millions per year)		
Direct	16.58	16.30	14.67	13.20	11.97
Indirect/induced	3.90	3.83	3.45	3.11	2.81
Total	20.48	20.14	18.12	16.31	14.78
Range of income gain or loss		(0.32 – 0.34)	(2.21 – 2.36)	(3.91 – 4.17)	(5.53 – 5.70)
Province[c] (including Invermere TSA)					
Employment			(person-years)		
Direct	703	613	552	497	450
Indirect/induced	774	675	608	547	496
Total	1,477	1,288	1.159	1,043	946
Range of employment gain or loss		(160 – 189)	(270 – 318)	(368 – 434)	(452 – 531)
Employment income			($ millions per year)		
Direct	33.32	29.06	26.16	23.54	21.33
Indirect/induced	23.47	20.47	18.47	16.58	15.02
Total	56.79	49.53	44.58	40.12	36.36
Range of income gain or loss		(6.40 – 7.26)	(10.76 – 12.21)	(14.69 – 16.67)	(18.01 – 20.43)
Provincial government revenues			($millions per year)		
Stumpage and related payments	10.28	10.11	9.10	8.19	7.42
Forest industry taxes	4.63	4.55	4.10	3.69	3.34
Employee income taxes	4.36	4.28	3.85	3.47	3.14
Total	19.27	18.94	17.05	15.34	13.91
Gain (reduction) in revenues		(0.32 – 0.32)	(2.16 – 2.22)	(3.83 – 3.92)	(5.23 – 5.36)

(a) Estimates for current employment differ from those in Tables 10-12. Employment figures in this table are based on the current AAC of 591 500 cubic metres, while the figures in Tables 10-12 are based on the 1997-1999 average annual harvest volume of 584 126 cubic metres. Due to rounding, some totals may not equal the sum of their components.

(b) The ranges for employment and income changes take into consideration employment insurance and other social assistance programs that provide temporary short-term income to unemployed or displaced workers. The range's upper limit assumes that all those who are unemployed or displaced will leave the TSA to seek opportunities elsewhere and will no longer spend their income locally, thus imparting a higher impact on the local economy than if they had not left. The range's lower limit assumes that employment insurance and other social assistance payments to unemployed or displaced workers will temporarily encourage them not to leave the community, thus reducing the induced impacts of a lower harvest level. The actual impacts of changes in harvest levels on employment and incomes will likely fall within the specified ranges. Additional explanations and details are in Appendix B.

(c) Estimates of TSA employment and income impacts are included as part of the estimates of provincial employment and income impacts.

7.3.3 Provincial government revenues

Provincial government revenues from the forest industry include stumpage, royalties, and rent payments; other taxes such as logging, corporate income, sales, property, and electricity taxes; and income taxes from direct, indirect and induced employment. Under the existing tax and stumpage regimes, the base case harvest forecast of 581 570 cubic metres per year if fully harvested would generate, on average, an estimated $18.9 million annually in provincial government revenues.

During the second decade, the base case harvest forecast would generate an estimated $17.1 million in provincial revenues; for the third decade, $15.3 million and for the fourth and subsequent decades, $13.9 million.. Assuming that there will be no changes to tax rates or to stumpage-related charges and provided that the entire volume is harvested and fully utilized, annual provincial government revenues will decrease by about $300,000 for the first decade, and by approximately $5.2 to $5.4 million by the fourth decade, from the current level.

7.3.4 Community impacts

The impacts of short- and long-term changes in timber supply will be much greater on an economy which is dependent on the local timber supply than on one which is more diversified. The base case harvest forecast indicates that the current AAC shows a reduction less than 2% (to account for woodlot licences) for the first decade, providing a relative degree of stability to the level of forestry activity in the Invermere TSA. By the fourth decade, the base case harvest forecast is approximately 28% less than the current AAC of 591 500 cubic metres. Unlike other communities in the province, the economy of the Invermere TSA is relatively diversified. In the coming decades, as the forest sector becomes relatively less important to the TSA's economy, new investments in services and light industries could be attracted to the TSA to further broaden its economic base.

7.3.5 Nature, production capabilities and timber requirements of local processing facilities

Between 1997 and 1999, harvest levels in the Invermere TSA averaged 584 126 cubic metres per year. Approximately 80% of the timber harvested was processed within the TSA. The estimated timber processing capacity in the Invermere TSA is 1.2 million cubic metres per year.

To operate at full capacity, TSA mills acquire timber from other TSAs or provinces, and private sources. Any reductions in the future would be expected to put additional pressure on local milling operations.

7.3.6 Regional timber supply issues

The movement of timber across TSA boundaries means that communities in the Invermere TSA can be vulnerable to timber supply changes in other TSAs. Information from the previous timber supply reviews indicate that the timber supply in the south-east Kootenay region could decline by about 18% or almost 409 000 cubic metres by the year 2017.[4] Since mills in the Invermere TSA depend on neighbouring management units for about 35% of their timber supply (including private sources), future reductions in neighbouring timber supply areas could affect the timber supply available to these mills. However, this outlook may change as each successive timber supply review re-examines the timber supply in the region. The *Kootenay-Boundary Land Use Plan* may have further implications for communities as the timber supply adjusts to meet the objectives of the land use plan. How these processes may eventually impact the Invermere TSA will depend on the actual timber supply changes, the composition of the industry, and timber flows at the time.

(4) These estimates are based on the most recent timber supply reviews base case forecast for Kootenay Lake, Invermere, Cranbrook and Golden TSAs. The combined timber supply volumes for these management units is currently 2.68 million cubic metres per year and the harvest level is forecast to be 2.19 million cubic metres per year by 2017.

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7.4 Summary

The forest sector is one of three major sectors in the Invermere TSA's economy. Major forest licence holders in the TSA include Crestbrook Forest Industries Ltd. and Slocan Forest Products Ltd. Together, they account for close to 85% of the apportioned volume in the TSA. The Ministry of Forests' Small Business Forest Enterprise Program accounts for an additional 10%. Primary timber processing plants include seven lumber mills, one pole plant and a pulp mill.

The base case harvest forecast for the Invermere TSA indicates that the allowable annual cut could be maintained at 581 570 cubic metres per year for the next decade. This level of forestry activity would support an estimated 1,288 person-years of employment (includes direct, indirect and induced jobs) and employment income of $49.5 million in the province. An estimated $18.9 million per year in provincial government revenues would be generated. Within the Invermere TSA, the volume from the base case harvest forecast in the next decade would support an estimated 477 person-years of employment and generate an estimated $20.1 million in employment income.

Because the base case harvest forecast in the next decade indicates that the current allowable harvest level in the TSA could be maintained, it is likely that employment, employment income and provincial government revenues will also be slightly impacted. Licensees will likely be able to adjust to the slightly lower level of activity and operators can continue to rely on timber supply from both TSA and non-TSA sources.

By the fourth decade, the base case harvest forecast will be 426 881 cubic metres per year, approximately 27% less that the current AAC. This volume of timber supply will support an estimated 946 person-years of employment and generate an estimated $36.4 million in employment income in the province. The economy of the Invermere TSA is diversified and in the coming decades, as the primary forest sector activities becomes relatively less important to the TSA's economy due to reduced timber harvest levels, new investments in secondary wood processing, services and light industries could be attracted to the TSA to further broaden its economic base.

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9 Glossary

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.
Analysis unit	A grouping of types of forest - for example, by species, site productivity, silvicultural treatment, age, and or location, done to simplify analysis and generation of timber yield tables.
Base case	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Clearcut harvesting	A harvesting method whereby all trees that meet utilization standards are harvested. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding.
Coniferous	Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Culmination age	The age at which a timber stand reaches its highest average growth rate, or mean annual increment (MAI). MAI is calculated as stand volume divided by stand age. Culmination age is the optimal biological rotation age to maximize volume production from a growing site.
Deciduous	Deciduous trees commonly have broad-leaves and usually shed their leaves annually.
Employment coefficient	The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.
Employment multiplier	An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.
Environmentally sensitive areas	Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.

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Forest cover objectives

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Green–up**).

Forest cover requirements

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Green–up**).

Forest inventory

An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Forest Practices Code

Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Free-growing

An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

Green-up

The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

Growing stock

The volume estimate for all standing timber at a particular time.

Harvest forecast

The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

Indirect and induced jobs

Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

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Inoperable areas — Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.

Integrated resource management — The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

Juvenile spacing — A silvicultural treatment to reduce the number of trees in young stands, often carried out before the stems removed are large enough to be used or sold as a forest product. Prevents stagnation and improves growing conditions for the remaining crop trees so that at final harvest the end-product quality and value is increased.

Landscape-level biodiversity — The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.

Landscape unit — A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Long-term harvest level — A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

Management assumptions — Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

Mean annual increment (MAI) — Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.

Model — An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

9 Glossary

Not satisfactorily restocked (NSR) areas An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

Old seral Old seral refers to forests with appropriate old forest attributes which provide for biodiversity. Ages vary depending on biogeoclimatic variant and are specified in the *Landscape Unit Planning Guide*.

Operability Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.

Person-year(s) One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Pruning The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

Regeneration delay The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.

Riparian area Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

Riparian habitat The stream bank and flood plain area adjacent to streams or water bodies.

Scenic area Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.

Sensitivity analysis A process that examines how uncertainty in data and management assumptions affect timber supply.

Shelterwood system Involves leaving a significant proportion of the mature, merchantable trees standing after an initial harvest to provide seed and shelter to assist in establishing a new stand. Usually the shelter trees are harvested after the new stand is well established.

Site index A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

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Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Timber harvesting land base	Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Tree farm licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.
Woodlot licence	An agreement entered into under the *Forest Act*. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

The following tables and discussion outline the methods and inputs used to derive the timber harvesting land base, and to construct the timber supply model for the Invermere TSA timber supply analysis. This information represents current forest management in the area.

Current management is defined as the set of land-use decisions and forest and stand management practices currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced, are not included in this appendix.

The purpose of the Timber Supply Review is to provide information on the effects of current management on both short- and long-term timber supply in each timber supply area in the province. Any changes in forest management objectives and practices, and any improvements to the data will be included in subsequent timber supply analyses.

More detail on the derivation of many of the land base exclusions and modelling approaches is available in the March 2000 *Invermere Timber Supply Area Timber Supply Review Data Package*.

A.1 Inventory Information

Table A-1. Inventory information

Data	Source	Vintage	Update	Source scale
Forest cover	Ministry of Forests (MoF) standard inventory files	01/98	01/98	1:20 000
Ownership	Crown lands	02/96	02/96	1:20 000
Woodlots	District source files	03/99	03/99	1:20 000
Biogeoclimatic ecosystem classification (BEC)	Provincial base data file with regional updates	1994	11/96	1:50 000
NSR data	MLSIS[a] and ISIS[b]	04/99	04/99	N/A
Provincial parks forest cover	KBLUP file — regional non-standard inventory files	1972	1999	1:20 000
Caribou habitat	Ministry of Environment, Lands and Parks (MELP) biophysical mapping with reference to KBLUPIS	05/97	05/97	1:50 000
Ungulate winter range (other than caribou)	MELP biophysical mapping	1979	1996	1:50 000
Community watersheds	MoF non-standard file taken from MELP CW source	1997	N/A	1:20 000
Riparian areas	MoF non-standard file generated using ortho photo mapping interpretation	1998	1998	1:20 000
Visual landscape inventory	MoF standard recreation files (VQO component) within KBLUP scenic corridor only	1993	1998	1:50 000
Eco-restoration emphasis	MoF non-standard file from ground and photo inventories	1998	1998	1:20 000
Operability	MoF standard file	1987	1997	1:50 000
Silviculture practices; not satisfactorily restocked area	ISIS / MLSIS	Ongoing	May 1999	1:20 000
Draft landscape unit boundaries	MoF non-standard file	1996	1998	1:20 000
Draft biodiversity emphasis	Defined by landscape unit as per KBLUP, MoF-MELP MOU, and Forest Development Plan (FDP) instructions	10/96	2000	1:20 000
Slope	MoF standard inventory files	05/97	05/97	1:20 000
Columbia River wetland management area	KBLUP file — regional non-standard inventory file	05/97	—	1:50 000

(a) MLSIS is Major Licensee Silviculture Information System.

(b) ISIS is Integrated Silviculture Information System.

A.1 Inventory Information

Data source and comments:

The photo interpretation and field work for the Invermere TSA forest cover re-inventory was completed in 1992 to the NAD83 TRIM base. The last forest cover update includes all changes from timber harvesting, wildfire, re-establishment of commercial tree species, and forest growth up to January 1, 1998.

All protected areas in the Invermere Forest District have forest cover information in the standard forest inventory file. These areas include: the Purcell Wilderness Conservancy, and Top of the World, Height of the Rockies, Whiteswan, Bugaboo and Mt. Assiniboine Provincial Parks. Forested areas in parks do not contribute directly to timber supply (i.e., are not part of the area available for harvest), but contribute to seral-stage targets for biodiversity in the landscape unit to which the park belongs.

The caribou habitat mapping is part of the MELP biophysical mapping with reference to the *Kootenay Boundary Land Use Plan Implementation Strategy* (KBLUPIS), which was approved by government in 1997.

The linework for the ungulate winter range is based on the MELP biophysical mapping and was further refined in 1998 to more accurately correspond to the existing wildlife biophysical inventory.

Draft landscape unit boundaries and biodiversity emphasis options (BEOs) were determined jointly by the Ministry of Forests (MoF) and the Ministry of Environment, Lands and Parks (MELP) as per the *KBLUPIS*. The Invermere Forest District Manager has made reference to these boundaries in his last two letters of FDP instructions to licensees. In all, 34 draft landscape units have been delineated within the Invermere TSA and are defined by a separate landscape unit overlay. It is expected that these landscape units and the corresponding *Kootenay Boundary Land Use Plan* (KBLUP) biodiversity emphasis options will be established soon.

Riparian reserve areas were mapped is a non-standard layer using ortho photos in 1998. They were excluded from the timber harvesting land base.

A.2 Zone and Analysis Unit Definition

A.2.1 Management zones, groups and multiple objectives

Management zones represent areas with distinct management emphasis. For example, a management zone may be based on a harvesting system, silviculture system, visual quality objective, or wildlife consideration. Some areas may be subject to more than one management objective. For simulation modelling, a "group" function enables application of overlapping constraints.

Table A-2. provides general descriptions of the management objectives and related information tracked in the analysis. The non-contributing forest (i.e., land considered unavailable for timber harvesting) is included for consideration in attaining forest cover objectives for landscape level biodiversity and visual quality.

Section A.4.10, "Forest cover requirements" includes further information on the requirements to be applied.

Table A-2. Group definition

Description	Inventory definition	Objectives
All forested land by landscape unit (LU)	Ministry of Forests (MoF) non-standard layer	Reporting. Provide an assessment of the total forest by landscape unit. All Crown forested area (including provincial parks if in the landscape unit).
Timber harvesting land base (THLB) by landscape unit (LU)	MoF non-standard layer	Reporting. Provide an assessment of the total timber harvesting land base by landscape unit.
Biodiversity	Biogeoclimatic ecosystem classification (BEC) from MoF standard layer	Apply seral stage requirements for biodiversity at the LU / BEC subzone level. All Crown forested area included.
Visuals	MoF standard layer: within mapped scenic corridor	Applying green-up requirements according to provincial guidelines (*Procedures for Factoring Visual Resources in Timber Supply Analyses*). All Crown forest by visual zone (retention or partial retention) by landscape unit.
Watershed	MoF non-standard layer	Applying green-up requirements as per Nelson Regional weighted guidelines. All timber harvesting land base by landscape unit by watershed zone.
Ungulate winter range (UWR)	Ministry of Environment, Lands and Parks (MELP) biophysical mapping	Application of cover requirements to provide snow interception cover as per *EFMPP Strategy Report*. All timber harvesting land base by landscape unit by ungulate winter range zone.
Trench plan: eco-restoration	MoF non-standard layer — from eco-restoration plan	Portions of forest produce one-half of normal yields to promote forage production. All timber harvesting land base by landscape unit by trench zone.
Integrated resource management	Area outside all other defined zones	Application of 3-metre green-up requirement to approximate *FPC* cutblock adjacency requirements.
Caribou	MELP biophysical mapping and reference to KBLUPIS	Application of mature- and old-growth requirements for caribou habitat across the specified extent of each zone. All timber harvesting land base by landscape unit by caribou zone.

Data source and comments:

See Section A.1, "Inventory information" for the sources of the zones referenced above.

A.2 Zone and Analysis Unit Definition

A.2.2 Analysis units

An analysis unit represents forest stands with similar tree species (as indicated by the inventory type group), similar timber growing capability (as indicated by the site index in the forest inventory file) and similar management regimes. Each analysis unit was assigned its own timber volume projections (growth curves) for existing and future stands.

Yield tables for existing natural stands was derived using the variable density yield prediction (VDYP) yield model. Yield tables for recent plantations and future stands was derived using the table interpolation program for stand yields (TIPSY).

Table A-3. Definition of analysis units

Analysis unit number	Species	Site index range (m @ 50 years)	Inventory type groups	Slope (%)	BEC/NDT
01	Douglas-fir/Py	> 15.5	1–8, 32	—	All
02	Douglas-fir/Py	13–15.5	1–8, 32	—	All
03	Douglas-fir/Py	< 13	1–8, 32	—	All
04	Larch	> 17	33, 34	—	All
05	Larch	13.5–17	33, 34	—	All
06	Larch	< 13.5	33, 34	—	All
07	Spruce, balsam	> 15	18–26	—	All
08	Spruce, balsam	12–15	18–26	—	All
09	Spruce, balsam	< 12	18–26	—	All
10	Cedar, hemlock	All	9–17	—	All
11	Lodgepole pine – flat	> 16	27–31	≤ 40%	All
21	Lodgepole pine – steep	> 16	27–31	> 40%	All
12	Lodgepole pine – flat	13–16	27–31	≤ 40%	All
22	Lodgepole pine – steep	13–16	27–31	> 40%	All
13	Lodgepole pine – flat	< 13	27–31	≤ 40%	All
23	Lodgepole pine – steep	< 13	27–31	> 40%	All
31	Partial cut FdLwPy > 30%	> 16	Not 33, 34	≤ 40%	Non-ESSF
32	Partial cut FdLwPy > 30%	13–16	Not 33, 34	≤ 40%	Non-ESSF
33	Partial cut FdLwPy > 30%	< 13	Not 33, 34	≤ 40%	Non-ESSF

Data source and comments:

Stands must have at least 30% composition of Douglas-fir, larch and yellow pine to be assigned to partial cut analysis units (31-33). Larch-leading sites (inventory types groups 33 and 34) are not partially cut.

Growth of stands younger than 31 years of age as of January 1st, 1998 will be projected with managed stand yield tables generated using TIPSY. Managed stands will be identified for the analysis according to the above table, except with a "100" prefix (for example 101, 102, 103 and so on).

A.3 Definition of the Timber Harvesting Land Base

A.3.1 Land not owned and administered by the province of British Columbia

Land must be British Columbia Crown land under provincial administration for it to contribute to the land base used to determine timber supply. Private lands (Crown granted lands — ownership code 40-N) and federal Crown lands (Indian Reserves — ownership code 52-N) do not contribute to the timber harvesting land base or other forest management objectives in the TSA, and were deducted from the land base that will be modelled in the analysis. Land under provincial Crown administration may contribute to forest management objectives even if it is not available for timber harvesting. For example, provincial park land provides old growth to help achieve biodiversity objectives.

A.3.2 Land classified as non-forest or non-productive forest

Alpine, lakes, rock, etc., represented by inventory type identities 6 and 8, were excluded from the timber harvesting land base.

A.3.3 Non-commercial cover

Inventory type identity 5 represents areas currently occupied by non-commercial brush species. These areas are considered unlikely sites for timber production and were excluded from the area available for timber harvesting.

A.3.4 Land not administered by the British Columbia Forest Service for timber supply

The total land base is stratified into various ownership codes. Of the provincial Crown ownership codes, only three are considered to contribute to timber supply for harvest forecast and AAC determination purposes: 62-C (Crown land in a forest management unit), 69-C (Crown land in miscellaneous reserves), and 61-C (contributing large Use, Recreation, and Enjoyment of the Public [UREP] areas). UREP areas smaller than 100 hectares were removed from the timber harvesting land base.

A.3.5 Woodlot licences

These areas of Crown timber land are managed for timber production. However, they are administered separately from the TSA. While the Minister of Forests initially apportions a part of the TSA AAC to woodlots, once an AAC is allocated to a specific woodlot licence, the area and the associated AAC are no longer administered as part of the TSA. Consequently, allocated woodlots do not contribute to the TSA timber harvesting land base.

A.3.6 Roads, trails and landings

Estimates are made to reflect the loss of productive forest land to existing and future roads, trails and landings (RTLs).

A.3.6.1 Existing mapped roads, trails and landings

All existing mapped roads were deducted from the timber harvesting land base (not including roads mapped as double line features in the inventory, which are deducted as non-forest). The deduction was based on a geographic information system (GIS) linear overlay assuming an average road width of 20 metres for all secondary and logging roads, and 10 metres for trails. The mapping and buffering of the linear features allowed for area-specific land base exclusions. The area removed totals 2.6% of the timber harvesting land base.

A.3 Definition of the Timber Harvesting Land Base

A.3.6.2 Existing non-classified in-block trails and landings

Table A-4a. Estimates of non-classified existing roads, trails and landings

RTL category	Area equivalent of all losses (%)	Rationale/source
Skid trails (including old historic trails, and other detrimental disturbance on the net area to reforest)	4.5	Small Business Forest Enterprise Program (SBFEP) soil disturbance surveys in 1994, 1995.
Landings	3.0	Based on one-quarter hectare landing per eight hectares harvested.
Total	7.5	Includes estimated 1% overlap of mapped roads already excluded (see notes).

Data source and comments:

These estimates are from 1994-1995 site disturbance surveys conducted throughout the TSA on SBFEP blocks. The subsequent GIS overlay done in 1999 includes some roads through cutblocks. The overlap is estimated to be approximately 1%, therefore existing in-block trails and landings were accounted for by applying an operational adjustment factor (OAF) of 6.5% to the volume yield curves for existing regenerated stands.

A.3.6.3 Future roads, trails and landings

Table A-4b. Estimates of productivity losses due to future roads, trails and landings

RTL category	Productivity reduction (%)	Rationale
Roads	0.6	Soil disturbance surveys from Invermere, Golden and Cranbrook Forest Districts – 1994.
Skid trails (including old historic trails, and other detrimental disturbance on the net area to reforest.)	4.5	SBFEP soil disturbance surveys in 1994, 1995.
Landings	3.0	Based on one-quarter hectare landing per eight hectares harvested.
Total	8.1	

Data source and comments:

This reduction applies to future stands on areas currently not harvested and is a one time reduction to reflect areas that will be occupied by future roads, trails and landings once harvest is complete.

A.3 Definition of the Timber Harvesting Land Base

A.3.7 Riparian area

A.3.7.1 Riparian reserve zone

Riparian habitat was mapped for the entire TSA from 1:20 000 orthophoto maps (1995 photos) and represents the area in riparian reserves associated with S3 and larger streams as well as lakes. The mapping of reserves allowed for spatially explicit land base exclusions. Riparian reserves amount to a 2.0% reduction to the timber harvesting land base.

A.3.7.2 Riparian management zone

Timber harvesting is restricted, but not precluded in riparian management zones. A reduction to the volume tables was used to account for the management zones (see Section A.4.11, "Reductions to reflect volume retention in cutblocks").

A.3.8 Environmentally sensitive areas

Some lands are environmentally sensitive and/or significantly valuable for other resources. These areas are identified during a forest inventory as environmentally sensitive areas (ESAs). Table A-5. lists the types of ESAs where no harvesting is expected to take place, and which will be excluded from the timber harvesting land base.

Table A-5. Description of environmentally sensitive areas

ESA class	ESA description	Site index (m @ 50 years)	Per cent (%) area reduction
E1a	Stands having severe snow chute or avalanche problems.	All	100
E1h	Stands containing licensed domestic water intakes.	All	100
E1s	Areas with fragile or unstable soils.	< 17[a]	100
E1p	Areas where severe plantation problems are expected.	All	100

(a) Stands on highly sensitive soils (E1s) on good sites (SI > 17) are normally harvested using sensitive harvesting techniques.

Data source and comments:

Reductions for ESAs are based upon forest district staff and licensee advice and analysis of harvesting activities planned over the next 5 years on areas classified as ESAs. All moderately sensitive areas (E2s) are included in the timber harvesting land base, since environmental considerations in these areas are normally addressed during operations without any effect on timber availability.

Management in E1w (wildlife) areas was addressed through forest cover constraints.

A.3 Definition of the Timber Harvesting Land Base

A.3.9 Sites with low timber growing potential

Low productivity stands that are not expected to produce an economically harvestable crop of trees in a reasonable length of time were excluded from the timber harvesting land base.

Table A-6. Description of sites with low timber growing potential

Species	Inventory type groups	Site index (m @ 50 years)	Per cent (%) area reduction
Spruce	20 – 26	< 8	100
Other	All others	< 10	100

Data source and comments:

The site index cutoffs are based on current harvesting practices, and district staff and licensee input.

A.3.10 Broadleaf deciduous forest types

All deciduous-leading forest types are excluded as non-merchantable as they are not presently utilized.

Table A-7. Excluded deciduous forest types

Type group	Species	Age	Height class	Per cent (%) area reduction
35, 36, 40, 41	Deciduous	All	All	100

Data source and comments:

The secondary deciduous components of coniferous-leading types are not excluded although may not be harvested in practice. However, this is balanced by the fact that coniferous secondary components in deciduous stands (type groups 35 and 41 listed above) were removed but may be harvested in practice. The area affected is less than 300 hectares and considered incidental to this analysis.

A.3.11 Inoperable areas

Operability codes are used to classify areas based on physical or economic considerations that affect the ability to harvest stands. Characteristics used in defining operability include slope, topography (e.g., gullies or exposed rock), difficulty of road access, soil instability, elevation and timber quality. Operability can change over time with new harvesting technologies and changing economics.

Table A-8. Description of inoperable areas

Operability code	Species	Slope	Site index (m @ 50 years)	Per cent (%) area reduction
Inoperable (I)	All	All	All	100
Operable (A)	Fir, L, Py	> 60%	< 13	100
Operable (A)	Pl, S	> 50%	< 13	100
Operable (A)	Pl	> 60%	< 14.2	100

A.3 Definition of the Timber Harvesting Land Base

Data source and comments:

Operable areas are those parts of the Invermere TSA forested land base which are likely to be accessible for timber harvesting when considering ecological, economic and terrain factors.

The 'operability line' is reviewed periodically by forest district (MoF) staff based on input from industry. During these reviews, some areas are added and others are deleted from the operable classification. The most recent minor amendments to the operability line were made in 1997. Some harvesting above the operability line is proposed. However, district field staff indicate that there is likely an equivalent proportion of the land base currently designated as operable that, upon operational checking would be inoperable.

Currently, timber harvesting is not considered economically viable on steeper slopes and poorer sites. Table A-8. lists the combined thresholds of site, species and slope used to exclude steep slope areas. Forest district staff derived this data with input from licensees. A sensitivity analysis will be done to determine the effect on the timber supply forecast if harvesting were to occur on these areas

A.3.12 Problem forest types

Problem forest types occupy sites that have the potential to produce merchantable timber, but currently are not utilized due to marginal economics (low volumes and/or quality).

Table A-9. Problem forest types criteria

PFT #	Type group	Species	Slope	Age (years)	Height class	Stocking class	Site index (m @ 50 years)	Per cent (%) excluded
1	1, 8, 32-34	Fir, L, Py	All	> 80	1, 2	0	< 12.0	100
2	28-31	Pl leading	> 30%	> 40	1, 2	0	< 16.0	100
3	28-31	Pl leading	All	> 60	1, 2	0	< 13.5	100

Data source and comments:

All problem forest types (PFT) will be tracked separately in the model to facilitate sensitivity analyses.

Hugh Hamilton Limited did a problem forest type inventory during 1998 which helped guide the PFT definitions. The objective of the inventory was to avoid applying percentage land base exclusions to stand types and determine if specific stands should either be totally included or totally excluded. The project is ongoing and when completed, will refine the thresholds for identifying PFTs and separate the marginally productive stands from the problem stands for the next timber supply review.

Height classes 1 and 2 represent heights of 19.4 metres and less. Stocking class 0 is the code applied to undisturbed immature stands.

A.3.13 Cultural heritage resources

Cultural heritage values include archaeological sites and traditional uses of the land. Archaeological overview assessments (AOA) have been completed for various landscape units in the Invermere TSA. The AOAs classify areas according to high, medium or unranked archaeological potential. Archaeological impact assessments are required in areas identified as medium or high potential prior to proceeding with development. These assessments have resulted in deferral from harvest of a very small portion (less than 10 hectares) of some of the areas classified as having high or medium archaeological potential. Based on current practices, the area of harvest deferred for archeological values is minimal across the timber harvesting land base, and no exclusions were made for this timber supply review.

A Traditional Use Study (TUS) is currently being conducted by the Ktunaxa / Kinbasket Tribal Council which will provide extensive information on the traditional uses of the Ktunaxa / Kinbasket peoples. At this time, the forest district has not been made aware of specific traditionally used resources which are in scarce supply and would require restrictions in timber harvest to provide for future traditional uses.

A.4 Forest Management Assumptions

A.4.1 Utilization levels

The utilization levels define the maximum stump height, minimum top diameter inside bark (dib) and minimum diameter at breast height (dbh) by species and are used in the analysis to calculate merchantable volume.

Table A-10. Utilization levels

Analysis unit	Minimum dbh (cm)	Maximum stump height (cm)	Minimum top dib (cm)
Lodgepole pine	12.5	30	10
All other species	17.5	30	10

Data source and comments:

These levels reflect current interior utilization standards, licence requirements and current performance. Cedar is utilized to a minimum top diameter of 20 cm, but comprises a very minor portion of the timber in the Invermere TSA, so the difference is considered inconsequential in the analysis.

A.4.2 Minimum harvestable age derivation

Minimum harvestable ages (MHAs) provide an estimate of the minimum age a stand must reach before it can be harvested. Tables A-11. and A-12. provide statistics related to the definition of MHAs for existing and regenerated stands.

A.4 Forest Management Assumptions

Table A-11. Minimum harvestable age criteria for existing natural stands using VDYP

Analysis unit	Species	SI range (m @ 50 years)	Slope	Minimum volume (m^3/hectare)				Minimum average DBH (cm)				Culmination age (max MAI years)	95% of max MAI age (years)	MHA for analysis (years)
				≤ 40% slope		> 40% slope		≤ 40% slope		> 40% slope				
				Vol	Age	Vol	Age	DBH	Age	DBH	Age			
01	Fd/Py	> 15.5	—	100	58	250	110	22.5	55	27.5	81	100	80	100
02	Fd/Py	13-15.5	—	100	72	250	162	22.5	60	27.5	92	120	90	120
03	Fd/Py	< 13	—	100	92	250	250	22.5	69	27.5	105	130	100	100
04	Larch	> 17	—	200	82	250	98	22.5	50	27.5	86	110	80	100
05	Larch	13.5-17	—	200	113	250	140	22.5	66	27.5	104	130	100	120
06	Larch	< 13.5	—	200	>250	250	>250	22.5	80	27.5	130	140	120	120
07	Spruce, balsam	> 15	—	150	65	250	90	22.5	53	27.5	79	100	80	100
08	Spruce, balsam	12-15	—	150	83	250	125	22.5	65	27.5	95	120	90	120
09	Spruce, balsam	< 12	—	150	118	250	180	22.5	88	27.5	128	160	130	130
10	Cedar, hemlock	All	—	200	110	250	139	22.5	58	27.5	87	90	75	90
11	Lodgepole pine – flat	> 16	≤ 40	150	58	—	—	17.5	46	—	—	90	65	65
21	Lodgepole pine – steep	> 16	> 40	—	—	250	88	—	—	22.5	87	90	65	85
12	Lodgepole pine – flat	13-16	≤ 40	150	75	—	—	17.5	58	—	—	110	80	80
22	Lodgepole pine – steep	13-16	> 40	—	—	250	118	—	—	22.5	108	110	80	105
13	Lodgepole pine – flat	< 13	≤ 40	150	108	—	—	17.5	75	—	—	130	110	90
23	Lodgepole pine – steep	< 13	> 40	—	—	250	250	—	—	22.5	137	130	110	125
31	Part cut FdLwPy > 30%	> 16	≤ 40	100	58	250	110	22.5	50	27.5	76	100	70	95
32	Part cut FdLwPy > 30%	13-16	≤ 40	100	72	250	162	22.5	58	27.5	89	120	90	115
33	Part cut FdLwPy > 30%	< 13	≤ 40	100	92	250	250	22.5	68	27.5	105	140	110	105

A.4 Forest Management Assumptions

Table A-12. Minimum harvestable age criteria for regenerated stands using TIPSY

Analysis unit	Species	SI range (m @ 50 years)	Slope (%)	Culmination age (max MAI)	95% of max MAI age	MHA for analysis
101	Fd/Py	> 15.5	—	100	75	100
102	Fd/Py	13–15.5	—	120	85	110
103	Fd/Py	< 13	—	130	110	110
104	Larch	> 17	—	110	75	110
105	Larch	13.5–17	—	130	95	120
106	Larc'	< 13.5	—	140	125	120
107	Spruce, balsam	> 15	—	100	80	100
108	Spruce, balsam	12–15	—	120	90	110
109	Spruce, balsam	< 12	—	160	120	120
110	Cedar, hemlock	All	—	90	65	80
111	Lodgepole pine – flat	> 16	≤ 40	90	60	70
121	Lodgepole pine – steep	> 16	> 40	90	60	80
112	Lodgepole pine – flat	13–16	≤ 40	110	75	80
122	Lodgepole pine – steep	13–16	> 40	110	75	100
113	Lodgepole pine – flat	< 13	≤ 40	130	110	110
123	Lodgepole pine – steep	< 13	> 40	130	110	130
131	Part cut FdLwPy > 30%	> 16	≤ 40	100	75	95
132	Part cut FdLwPy > 30%	13–16	≤ 40	120	85	115
133	Part cut FdLwPy > 30%	< 13	≤ 40	140	110	115

Data source and comments:

The criteria considered to define minimum harvestable ages (MHAs) for existing mature forest (Table A-11.) were: minimum volume per hectare, minimum piece size, and achievement of 95% of culmination mean annual increment (MAI). MHA criteria were area-weighted for each specific analysis unit and a final MHA chosen. The choices were based on local experience, including different expectations regarding the different product types and values from various sites and species.

The criteria used to choose MHAs for regenerated stands in Table A-12. were culmination age, age at 95% of maximum MAI, slope and site class of specific species.

A.4 Forest Management Assumptions

A.4.3 Harvest scheduling priorities

For the Invermere TSA base case, the Forest Service Simulator (FSSIM) timber supply model selected stands to harvest based on relative oldest first (highest priority given to stands that are furthest above their respective MHA).

Currently the harvesting priority in the Invermere TSA is the salvage of pine stands attacked or threatened by mountain pine beetle. The model therefore had a priority to harvest pine analysis units first where available for the first two decades of the simulation.

A.4.4 Logging methods and silviculture systems

Table A-13. Harvesting methods trends

	Percentage (%) of harvest by area	
Harvest system	1987 to 1998	1996 to 1998
Ground based	91.1	91.2
Cable	8.7	8.6
Helicopter	0.04	0.2
Horse	0.2	0

Table A-14. Silviculture system trends

	Percentage (%) of harvest by area	
	1987 to 1998	1996 to 1998
Clearcut	46.7	30.6
Clearcut with reserves	4.9	15.5
Seedtree	20.4	7.5
Shelterwood	19.8	44.1
Selection	8.2	2.3

Data source and comments:

The data in these tables, current to April 1999, was generated from the Forest Tenure Administration System (FTAS) and the Integrated Silviculture Information System (ISIS) and is provided for information only.

A.4 Forest Management Assumptions

A.4.5 Unsalvaged losses

This section provides an estimate of average annual volume of timber on the timber harvesting land base that is damaged or killed and not salvaged. These losses are attributable to a number of factors which result in tree mortality including: insects, disease, blowdown, snowdown, and wildfires.

Table A-15. Estimated average annual unsalvaged loss in the timber harvesting land base

Cause of tree mortality	Average annual unsalvaged loss in the timber harvesting land base (m^3 per year)
Mountain pine beetle	11 664
Spruce bark beetle	38
Douglas-fir bark beetle	108
Balsam bark beetle	302
Dwarf mistletoe	1 763
Catastrophic blowdown / snow damage — mature stands	330
Non-catastrophic in-block blowdown / snowdown immediately adjacent to logged stands	5
Non-catastrophic in-block blowdown / snowdown immediately adjacent to roads	27
Wildfires	5 882
Total	20 119

Data source and comments:

All unsalvaged losses noted in the above table occur on the timber harvesting land base. Information regarding unsalvaged losses was collected from forest district staff, forest health overview flight maps, Forest Insect Disease Surveys (FIDS), wildfire maps, industry and Small Business Forest Enterprise Program (SBFEP) forest development plan maps, wildfire reports from the protection fire reporting system, and various other sources. Wherever possible, reliable data from as many years as possible was used to determine the extent of total losses to each causal agent. Where possible, the most current salvage logging performance of the forest licensees and SBFEP was deducted from the average historical losses to determine an estimate of losses. Local knowledge, estimates from staff, and professional judgment are a key part of the estimates of unsalvaged losses. The degree to which VDYP may or may not account for different types of unsalvaged losses (*Measurement of Pest Killed Timber*; Henningman, 1997) was considered. Future forest composition, species age class distribution and improved future access were also considered.

A.4 Forest Management Assumptions

A.4.6 Silviculture and regeneration activities

The silviculture program guides the mix of treatments to be carried out in the Invermere TSA. Table A-16. shows the proportion of each analysis unit to be treated under each silviculture regime and the expected average regeneration delay.

Growth of recent plantations (stands aged 30 years and less as of January 1, 1998) and future stands were projected using managed stand yield tables (MSYT) which was produced from the B.C. Forest Service table interpolation program for stand yields (TIPSY) growth and yield model. Where more than one regeneration regime exists for a given species, the MSYT's were averaged by their respective weighted area.

Table A-16. Regenerated stand assumptions by analysis unit

AU	Species description	Site index range (m @ 50 years)	Regen method A = artificial N = natural	Area weighted site index	% of analysis unit by method	Regen delay (years)	OAF (%)		Regen species (%)	Initial density (stems per hectare)	Thinning density (sph)
							1	2			
101	Fir/Py	> 15.5	A	17.1	50	3	15.0	10.8	Lw 40/F 30/Pl 30	1600	
			N		30		20.0		F 60/Lw 30/Pl 10	5000	1800
			N		20		20.0		F 60/Lw 30/Pl 10	3500	
102	Fir/Py	13 – 15.5	A	15	30	3	15.0	10.8	Lw 40/F 30/Pl 30	1600	
			N		40		20.0		F 60/Pl 30/Lw 10	5000	1800
			N		30		20.0		F 60/Pl 30/Lw 10	3500	
103	Fir/Py	< 13	A	11.8	50	3	15.0	8.2	Py 65/F 25/Pl 10	1600	
			N		25		20.0		F 60/Py 30/Pl 10	5000	1800
			N		25		20.0		F 60/Py 30/Pl 10	3500	
104	Larch	> 17	A	20.6	40	3	15.0	5.0	Lw 55/F 35/10 Pl	1600	
			N		60				Lw 60/F 35/Pl 5	5000	1800
105	Larch	13.5 – 17	A	16	40	3	15.0	5.0	Lw 55/F 35/Pl 10	1600	
			N		30		20.0		Lw 60/F 35/Pl 5	5000	1800
			N		30				Lw 60/F 35/Pl 5	3500	
106	Larch	< 13.5	A	10.9	30	3	15.0	5.0	Lw 60/F 35/Pl 5	1600	
			N		40		20.0		Lw 60/F 35/Pl 5	5000	1800
			N		30				Lw 60/F 35/Pl 5	3500	
107	Spruce, balsam	> 15	A	17.5	70	3	15.0	5.0	S 60/Bl 20/Pl 20	1600	
			N		30				Bl 50/S 30/Pl 20	5000	1800
108	Spruce, balsam	12 – 15	A	15	50	3	15.0	5.0	S 50/Bl 20/Pl 30	1600	
			N		20				Bl 60/S 30/Pl 10	5000	1800
			N		30				Bl 60/S 30/Pl 10	3500	

(continued)

A.4 Forest Management Assumptions

Table A-16. Regenerated stand assumptions by analysis unit (concluded)

AU	Species description	Site index range (m @ 50 years)	Regen method A = artificial N = natural	Area weighted site index	% of analysis unit by method	Regen delay (years)	OAF (%)		Regen species (%)	Initial density (stems per hectare)	Thinning density (sph)
							1	2			
109	Spruce, balsam	< 12	A	10.5	70	3	15.0	5.0	Bl 40/S 30/Pl 30	1600	
			N		30				S 60/Bl 30/Pl 10	5000	1800
110	Cedar, hemlock	All	A	19.6	80	3	15.0	5.0	Pl 50/S 50	1600	
			N		20				Pl 30/S 40/C 30	5000	1800
111 121	Lodgepole pine	> 16	A	19.2	50	3	15.0	8.7	Pl 40/Lw 30/F 30	1600	
			N		30		20.0		Pl 90/Lw 5/F 5	5000	1800
			N		20		20.0		Pl 90/Lw 5/F 5	4000	
112 122	Lodgepole pine	13–16	A	25	15.9	3	15.0	8.7	Pl 30/Lw 40/F 30	1600	
			N	40			20.0		Pl 90/Lw 5/F 5	5000	1800
			N	35			20.0		Pl 90/Lw 5/F 5	4000	
113 123	Lodgepole pine	< 13	A	25	11.0	3	15.0	8.7	Pl 30/Lw 40/F 30	1600	
			N	40			20.0		Pl 90/Lw 5/F 5	5000	1800
			N	35			20.0		Pl 90/Lw 5/F 5	4000	
131	Partial cut – FdLwPy > 30%	> 16	N	100	17.5	N/A	15.0	5.0	F 60/Lw 25/Pl 15	1600	
132	Partial cut – FdLwPy > 30%	13–16	N	100	15.7	N/A	15.0	5.0	F 60/Lw 25/Pl 15	1600	
133	Partial cut – FdLwPy > 30%	< 13	N	100	11.6	N/A	15.0	5.0	F 60/Lw 25/Pl 15	1600	

Data source and comments:

Most of the values in the above tables are estimates by local staff based on information about previous stand types and site index. Existing stands over 30 years old were assigned to VDYP curves for the first rotation, and then moved to TIPSY managed yield curves for subsequent rotations.

A.4 Forest Management Assumptions

Operational adjustment factors (OAFs) were applied to the managed stand yield curves as recommended by the Ministry of Forests, Research Branch. The standard default value of OAF 1, which accounts for stocking gaps in stands, is 15%. The standard default value of OAF 2, which accounts for breakage and waste (2%) and decay (3%), is 5%. OAF 1 has been increased by 5% in analysis units where seed tree silviculture systems are prevalent. OAF 2 has been increased in analysis units by up to 5.8% to account for losses due to *Armillaria ostoyae*. Additional losses due to *Phellinus weirii*, *Tomentosus* root rot, black stain root disease, spruce leader weevil, pine leader weevil, pine needle cast, *Elytroderma* needle disease, Douglas-fir needle cast, western gall rust, white pine blister rust, *Comandra* blister rust, Stalactiform blister rust, Warren's root collar weevil, turpentine beetle, and animal damage (porcupine, vole, bear, ungulates, rabbit, squirrel) likely exist. The relevance and magnitude of each of these growth loss factors varies by analysis unit. Quantification of losses due to these insects and diseases is very difficult and no additional increases in OAFs to account for these insects and diseases have been included.

The final OAFs will also reflect deductions for riparian management zones and wildlife tree patches (see Section A.4.11, "Reductions to reflect volume retention in cutblocks").

A field review of current regeneration performance as part of the EFMPP determined that regeneration delay averages 3 years for all analysis units. Although legal commitments may range as high as 9 years, in the case of the *Slocan Forest Products (SFP) Memorandum of Understanding (MOU)*, the performance is expected to continue to average 3 years.

A.4.7 Backlog not satisfactorily restocked areas (NSR)

Not satisfactorily restocked (NSR) areas consist of current NSR and backlog NSR, as identified by type identity 4 or 9 in the TSA FIP file. Backlog NSR areas were logged or disturbed before October 1, 1987, and do not have legally required reforestation obligations. Backlog NSR areas in this report were derived from the ISIS database. All NSR remains in the timber harvesting land base.

Table A-17. Not satisfactorily restocked (NSR) areas grouped by stocking level

Total backlog NSR in ISIS database (hectares)	Untreatable backlog NSR (hectares)	Restocked in 1-9 years from now (hectares)
2 121	930	1 191

Data source and comments:

The district silviculture data (ISIS) indicates that there are 2121 hectares of backlog NSR. Approximately 930 hectares of the backlog NSR areas identified in the ISIS database will not be operationally feasible to restock due to unplantable ground (shallow soils, extensive exposed rock and/or talus, excessive debris), or a lack of economic viability (inaccessible, too small to treat, too expensive to treat, etc). Much of this area should be reclassified from NSR to NP burn in the next re-inventory. Of the 1191 hectares of treatable NSR, approximately 400 hectares are close to required stocking levels and will be left to restock naturally. This area should become SR by the time of the next survey. A further 390 hectares of NSR was planted in 1999. This leaves only 401 hectares of backlog NSR, which will require treatment. For this analysis it will be treated as current NSR due to the limited extent of the problem (i.e., assigned species from ISIS and standard regeneration delay).

A.4 Forest Management Assumptions

A.4.8 Current not satisfactorily restocked areas (NSR)

Current NSR areas was assigned to analysis units using ISIS source data linked to the forest inventory by the opening number. Current NSR areas were logged or disturbed after October 1, 1987 and have legal reforestation obligations. Restocking of current NSR areas will be assumed to occur within the regeneration delays in Table A-16. Current NSR areas total approximately 18 182 hectares. Contributing to this total is some administrative delay entering regen survey results, as well as recent wildfires.

A.4.9 Enhanced yields

A.4.9.1 Improved stock

Currently, a narrow range of elevation/site combinations have available improved orchard stock. A greater proportion of required stock will become available as seed orchards come on line, however, the benefits for future harvest levels are uncertain due in part to natural regeneration (intended or otherwise), and uncertain commitments toward establishing key seed orchards for the TSA. Section 5.4 of this report discusses the potential gains attributable to this factor.

A.4.9.2 Fertilization

Forest fertilization has been practiced intermittently in the TSA. The most recent application was 1996, when 1500 hectares were fertilized. Future levels of forest fertilization are highly uncertain and fertilizer use is not assumed in base case future yields.

A.4.10 Forest cover requirements

As noted in Section 4.1, "Management zones, groups and multiple objectives," forest cover requirements were applied to model management for a number of objectives. The role of non-contributing forest (forest outside the timber harvesting land base) was considered for forest cover requirements related to landscape-level biodiversity (Table A-18.) and visual quality (Table A-19.). All forest cover requirements listed in Table A-19., except for visual quality apply to the timber harvesting land base.

A.4 Forest Management Assumptions

Table A-18. Biodiversity forest cover requirements

BEC	NDT	BEO	Mature + old minimum retention (%)	Mature + old minimum age (years)	Old seral minimum retention (%)	Old seral minimum age (years)
ESSFdk	3	High	34	121	21	141
ESSFdk	3	Moderate	23	121	14	141
ESSFdk	3	Low	14	121	14	141
ESSFwm	2	High	0[a]	121	13	251
ESSFwm	2	Moderate	0	121	9	251
ESSFwm	2	Low	0	121	9	251
ICHmk1	3	High	34	101	21	141
ICHmk1	3	Moderate	23	101	14	141
ICHmk1	3	Low	14	101	14	141
IDFdm2	4	High	51	101	19	251
IDFdm2	4	Moderate	34	101	13	251
IDFdm2	4	Low	17	101	13	251
MSdk	3	High	39	101	21	141
MSdk	3	Moderate	26	101	14	141
MSdk	3	Low	14	101	14	141
PPdh2	4	High	51	101	19	251
PPdh2	4	Moderate	34	101	13	251
PPdh2	4	Low	17	101	13	251

(a) Reflects direction in *Landscape Unit Planning Guide* not to apply mature plus old seral requirements.

Data source and comments:

Biodiversity management will be modelled using information from the *Landscape Unit Planning Guide* (LUPG). As per the *Regional Landscape Unit Planning Strategy*, it is anticipated that landscape units and biodiversity emphasis will be established prior to the Chief Forester's AAC determination.

In this analysis, the *Biodiversity Guidebook* seral stage requirements for mature plus old, and the *Landscape Unit Planning Guide* requirements for old were modelled to first be met wherever possible from the non-contributing land base. Where landscape unit boundaries extend into provincial park lands adjacent to the TSA, the park did not contribute to the timber harvesting land base, but will contribute to biodiversity forest cover.

Biodiversity forest cover requirements apply to all Crown forested land, both above and below the operability line. The forest not contributing to the timber harvesting land base within each landscape unit is assumed to age over the duration of the harvest forecast.

A.4 Forest Management Assumptions

Table A-19. Forest cover requirements for specific resource emphases

Resource emphasis	Green-up height (metres)	Green-up age (years)	Maximum area < green-up age (%)	Mature age (years)	Minimum area > mature age (%)	Old forest age (years)	Minimum area > old age (%)
IRM[a] – adjacency	3	12	25	—	—	—	—
Ungulate winter range	—	—	—	121	40	N/A	N/A
Caribou	—	—	—	141	30	251	10
Community watersheds	6	26	20	—	—	—	—
VQO — retention	4.0 to 8.5	24 to 39	5	—	—	—	—
VQO — partial retention	4.0 to 8.5	24 to 39	15	—	—	—	—
Trench	3	12	35	—	—	—	—

(a) Partial harvest analysis units are exempt.

Data source and comments:

All constraints will be applied by landscape unit and resource emphasis zone.

Early seral requirements for biodiversity will not be modelled as part of the base case. The maximum area less than green-up age within the watershed zones represents hydrological green-up constraints. The maximum area less that green-up age within the VQO and recreation zones reflects current management practices limiting the area of recent disturbance.

The maximum area less than green-up age within the integrated resource management (IRM) zone is intended to model block adjacency constraints. The integrated resource management zone encompasses that portion of that timber harvesting land base not occupied by any other zone or group, aside from biodiversity emphasis. Partial harvesting analysis units 31 – 33 and 131 – 133 are exempt from the green-up constraint, which reflects field operations.

To ensure an appropriate distribution of winter habitat, the KBLUPIS requires that each 250 to 500 hectare portion of ungulate winter range be managed as a discrete unit, with the forest cover requirements being met within each unit. This will not be modelled as part of the base case as it is beyond the resolution of the data. To ensure that the model reflects operational practices and that ungulate winter range is adequately distributed, the forest cover requirement will be applied on the timber harvesting land base portion of each landscape unit.

The VQO zones are wholly within the visually sensitive area "made known" in 1998. Licensees use the existing VQO Inventory within this area to guide current management as evidenced in recent FDPs.

The *EFMPP Strategy Report* outlines the *Large Patch Pine Strategy*, which is currently in being implemented in the TSA. Pine analysis units will therefore be priorized for harvest.

A.4 Forest Management Assumptions

A.4.11 Reductions to reflect volume retention in cutblocks

A.4.11.1 Wildlife tree patches (WTPs)

WTPs reserved within cutblocks operationally must be accounted for in the analysis. Tables A.3.1 and A.3.2 of the *Landscape Unit Planning Guide* recommend that the distance between WTPs within blocks does not exceed 500 metres. The guide also allows that any areas excluded from harvest for other reasons can serve as WTPs, and are expected to satisfy as much as 50% of this requirement. A GIS exercise was used to determine the ratio of timber harvesting land base within 250 metres of all other forest areas outside the timber harvesting land base, except private land, specific to each analysis unit. The appropriate guidebook percentage was then reduced to reflect the ratio and applied as an Operational Adjustment Factor (OAF) to the volume curves. In general, WTPs applied in this TSA are too small in size to contribute to landscape level biodiversity.

A.4.11.2 Riparian management zone

The extent of riparian management areas (RMAs) was estimated to be 1.2% of the timber harvesting land base from a GIS buffering exercise of the mapped riparian reserves, using a buffer width of 20 metres, as per the *FPC Riparian Management Area Guidebook*. The *FPC Riparian Management Area Guidebook*, as well as recent local experience was used to estimate the yield implication within the riparian management zone at 55%, and a corresponding reduction applied to all volume yield curves of 0.66%.

A.4 Forest Management Assumptions

A.4.12 Volume estimates for existing stands

The variable density yield projection (VDYP) model, Version 6.5a developed and supported by the B.C. Ministry of Forests, Resources Inventory Branch, was used to estimate timber volumes for existing natural stands. Table A-20. shows the volume estimates by analysis unit for existing natural stands.

A.4 Forest Management Assumptions

Table A-20. Projected volumes for natural stands using VDYP

	Species — site								
	Douglas-fir /Py – good	Douglas-fir /Py – medium	Douglas-fir /Py – poor	Larch – good	Larch – medium	Larch – poor	Spruce, balsam – good	Spruce, balsam – medium	Spruce, balsam – poor
	Analysis unit								
Age class	1	2	3	4	5	6	7	8	9
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	1	0	0	3	0	0	1	0	0
40	19	1	0	27	2	0	13	4	0
50	53	21	3	61	19	1	54	14	2
60	86	46	20	96	44	10	106	44	6
70	117	70	38	133	71	26	153	82	21
80	148	93	57	168	97	45	195	117	45
90	177	115	75	203	124	65	232	147	71
100	205	137	92	236	149	84	265	175	96
110	231	157	109	267	174	103	294	201	120
120	255	176	124	296	197	121	319	223	142
130	277	193	138	323	218	138	342	245	163
140	295	209	150	345	237	154	362	265	183
150	311	222	161	358	249	164	378	282	200
160	324	233	170	367	257	171	393	298	216
170	336	242	178	371	262	175	405	311	231
180	346	251	186	372	264	178	416	324	244
190	355	259	193	373	265	179	425	335	256
200	364	268	200	374	267	181	434	345	267
210	373	276	207	376	269	183	443	355	278
220	382	283	213	377	271	184	450	364	288
230	389	290	219	378	272	185	457	373	298
240	397	297	225	379	273	186	463	381	306
250	404	304	231	380	275	187	469	388	315
260	404	304	231	381	275	187	472	391	320
270	405	305	232	381	275	187	475	395	324
280	405	305	232	382	275	188	478	397	328
290	406	306	232	382	275	188	480	400	332
300	406	306	233	382	275	188	482	402	336
310	406	306	233	382	275	188	484	404	339
320	407	306	233	382	275	187	485	406	342
330	407	307	233	382	275	187	486	408	345
340	407	307	233	383	275	187	488	410	348
350	407	307	233	383	275	187	489	411	350

(continued)

Table A-20. Projected volumes for natural stands using VDYP (concluded)

	Species — site									
	Cedar, hemlock – all	Lodgepole pine – flat – good	Lodgepole pine – steep – good	Lodgepole pine – flat – medium	Lodgepole pine – steep – medium	Lodgepole pine – flat – poor	Lodgepole pine – steep – poor	Part cut FdLwPy > 30% – good	Part cut FdLwPy > 30% – medium	Part cut FdLwPy > 30% – poor
	Analysis unit									
Age class	10	11	21	12	22	13	23	31	32	33
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
30	1	22	16	0	1	0	0	6	0	0
40	15	75	67	29	28	2	3	34	4	0
50	43	123	113	68	67	23	24	71	24	4
60	76	166	153	103	102	50	52	106	47	18
70	107	202	188	135	133	76	78	139	70	34
80	136	235	220	163	161	99	101	170	92	50
90	160	265	249	190	188	121	124	199	113	66
100	180	293	275	214	212	142	144	227	134	81
110	198	318	300	237	235	162	164	253	154	96
120	214	342	322	259	256	180	182	276	171	110
130	233	364	343	279	276	198	200	297	188	122
140	251	379	358	293	289	210	212	314	202	133
150	267	390	369	304	300	221	222	328	214	143
160	283	397	376	312	308	228	230	340	225	151
170	297	402	381	316	313	233	235	350	234	159
180	312	403	382	319	315	236	239	358	242	165
190	325	401	381	318	315	237	239	365	249	172
200	338	403	383	321	318	240	242	372	257	178
210	351	406	386	323	320	243	246	379	264	184
220	365	409	389	326	323	246	249	386	271	190
230	379	411	391	329	326	249	252	392	277	195
240	393	414	394	332	329	251	254	398	283	200
250	406	416	397	334	331	254	257	404	288	205
260	408	418	398	336	333	256	259	404	289	205
270	409	420	400	338	335	258	261	405	289	205
280	410	422	402	340	336	259	262	406	290	206
290	411	424	403	341	338	261	264	406	290	206
300	411	425	405	342	339	262	265	407	290	206
310	412	427	406	344	340	263	266	407	291	207
320	413	428	407	345	341	264	267	408	291	207
330	414	429	408	346	342	265	268	408	291	207
340	414	430	409	346	343	265	268	408	291	207
350	415	431	410	347	343	266	269	408	291	207

A.4 Forest Management Assumptions

A.4.13 Volume estimates for regenerated stands

WinTIPSY (Windows™ version of the Table Interpolation Program for Stand Yields) version 1.4, supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed stands. Existing managed stands were assumed to be all stands with an age of 30 or less projected to January 1st 1998. The area-weighted site index for each analysis unit along with the regeneration assumptions in Table A-16. were used as inputs to TIPSY.

Table A-21. displays the volume tables for managed stands. These volume tables are generated from TIPSY for ages where TIPSY data exists, and estimated for ages beyond the TIPSY data set. Volumes are assumed to remain constant after 350 years of age.

Table A-21. Projected volumes for regenerated stands using TIPSY

	Species — site						
	Douglas-fir/Py – good	Douglas-fir/Py – medium	Douglas-fir/Py – poor	Larch – good	Larch – medium	Larch – poor	Spruce, balsam – good
	Analysis unit						
Age Class	101	102	103	104	105	106	107
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	0	0	0	1	0	0	0
40	7	2	0	18	1	0	11
50	28	12	0	74	10	0	57
60	69	36	2	148	36	0	127
70	116	67	10	210	76	2	200
80	160	101	23	268	124	10	261
90	196	135	45	320	164	26	321
100	226	162	66	367	198	47	369
110	256	187	91	410	229	68	402
120	279	207	111	444	258	92	428
130	300	224	130	472	283	111	450
140	319	239	147	472	305	128	464
150	333	253	161	472	323	144	478
160	345	264	175	472	342	157	489
170	356	273	187	472	356	168	494
180	363	281	197	472	367	178	497
190	369	287	204	472	379	187	497
200	375	292	211	472	388	194	496
210	379	297	218	472	396	201	494
220	380	300	222	472	401	208	493
230	382	302	228	472	406	213	493
240	380	305	233	472	411	216	493
250	383	306	235	472	413	220	493
260	381	305	238	472	417	223	493
270	380	302	241	472	419	226	493
280	380	302	244	472	423	229	493
290	379	299	245	472	425	230	493
300	377	297	245	472	427	232	493
310	377	297	245	472	427	232	493
320	377	297	245	472	427	232	493
330	377	297	245	472	427	232	493
340	377	297	245	472	427	232	493
350	377	297	245	472	427	232	493

(continued)

Table A-21. Projected volumes for regenerated stands using TIPSY

	Species — site						
	Spruce, balsam – medium	Spruce, balsam – poor	Cedar, hemlock – all	Lodgepole pine – flat – good	Lodgepole pine – steep – good	Lodgepole pine – flat – medium	Lodgepole pine – steep – medium
	Analysis unit						
Age Class	108	109	110	111	121	112	122
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	0	0	14	19	19	2	2
40	3	0	57	75	75	30	30
50	17	1	121	138	138	75	75
60	56	3	183	190	190	120	120
70	111	11	238	237	237	158	158
80	168	29	283	273	273	191	191
90	218	52	321	304	304	218	218
100	265	79	347	332	332	243	243
110	308	107	369	355	355	264	264
120	345	131	387	374	374	279	279
130	374	154	401	390	390	292	292
140	396	174	411	403	403	303	303
150	415	195	421	412	412	312	312
160	430	213	427	418	418	320	320
170	442	229	432	422	422	327	327
180	454	245	431	427	427	332	332
190	462	258	431	431	431	337	337
200	469	269	431	433	433	341	341
210	475	278	431	434	434	342	342
220	478	287	431	434	434	340	340
230	478	294	431	434	434	340	340
240	479	300	431	434	434	339	339
250	477	304	431	434	434	338	338
260	476	310	431	434	434	336	336
270	474	313	431	434	434	338	338
280	472	316	431	434	434	336	336
290	469	317	431	434	434	335	335
300	468	319	431	434	434	334	334
310	468	319	431	434	434	334	334
320	468	319	431	434	434	334	334
330	468	319	431	434	434	334	334
340	468	319	431	434	434	334	334
350	468	319	431	434	434	334	334

(continued)

Table A-21. Projected volumes for regenerated stands using TIPSY (concluded)

	Species — site							
	Lodgepole pine – flat – poor	Lodgepole pine – steep – poor	Part cut FdLwPy > 30% – good	Part cut FdLwPy > 30% – medium	Part cut FdLwPy > 30% – poor	Part cut FdLwPy > 30% – good	Part cut FdLwPy > 30% – medium	Part cut FdLwPy > 30% – poor
	Analysis unit							
Age Class	113	123	131	132	133	231	232	233
10	0	0	0	0	0	0	0	0
20	0	0	0	0	0	3	1	0
30	0	0	100	80	70	14	6	0
40	1	1	The volumes for partial cut AUs reflect a harvest return cycle of 30 years with the above expected harvest volumes.			35	19	1
50	9	9				60	37	4
60	24	24				84	57	10
70	46	46				104	76	20
80	69	69				123	93	30
90	89	89				140	108	40
100	109	109				155	121	49
110	126	126				169	133	59
120	140	140				181	145	67
130	153	153				193	154	74
140	163	163				202	162	81
150	171	171				210	170	87
160	178	178				216	176	92
170	185	185				223	183	96
180	191	191				228	189	101
190	195	195				233	193	103
200	200	200				237	198	107
210	202	202				240	202	109
220	204	204				243	203	112
230	206	206				246	206	113
240	207	207				249	209	116
250	209	209				250	210	118
260	209	209				253	213	120
270	211	211				254	214	121
280	211	211				256	216	122
290	212	212				256	216	122
300	213	213				256	216	122
310	213	213				256	216	122
320	213	213				256	216	122
330	213	213				256	216	122
340	213	213				256	216	122
350	213	213				256	216	122

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The report identifies employment and income impacts, changes in government revenues, and community impacts at various harvest levels and times in the future. This type of analysis requires several assumptions of which the reader should be aware. Some of these assumptions are outlined below:

- **Employment multipliers** — the multipliers used in the analysis of indirect and induced impacts are based on analytical assumptions and estimated using data collected at a certain time, thus they reflect industry and employment conditions at that time. Consequently, they may not accurately reflect future industry conditions. While generally sound indicators when based on fairly recent information, older multipliers may not reflect the industry under examination. In any impact analysis, the information should be considered as an order of magnitude indicator.
- **Employment coefficients** — employment impacts associated with future harvest levels are calculated using employment coefficients (person-years per 1000 cubic metres). This approach assumes that the industry structure will be the same in future as it is today. While reasonably accurate in the short term, employment coefficients may change due to changing market conditions or production technologies, for example.
- **Timing of impacts** — employment impacts are shown to occur simultaneously with a change in the harvest level. While fairly accurate for the harvesting sub-sector, this may not be the case for the processing and silviculture sub-sectors of the forest industry. Additionally, indirect and induced impacts will likely occur over a longer period of time, as business and consumer spending levels adjust.
- **Processing thresholds** — impacts on processing jobs are unlikely to occur in direct proportion to harvest changes (i.e., a 10% harvest reduction may not lead to a 10% processing employment reduction). Impacts related to processing thresholds are more likely to occur step-wise. A processing threshold is the level of a mill's timber supply where, when reached, will cause a mill to either lay off a shift or shut down the mill, temporarily or permanently. Accurately predicting a mill's threshold level is not possible. As a result, the analysis may overestimate processing impacts if mills continue to operate the same number of shifts, but perhaps at lower production levels. Alternatively, the analysis could underestimate impacts if a mill were to eliminate a shift. Over the medium- to long-term the impact figures should be reasonably accurate, however.
- **Government expenditures** — provincial government expenditures are more related to population levels than to industry activity. As such, expenditures on education, health care, and other government services are assumed to not change despite harvest changes and any subsequent change in government revenues. However, public expenditures would likely change if community population levels change sufficiently. This change would amplify the community impacts of forestry job losses or gains.
- **Proportional harvest reductions** — harvest reductions are assumed to be spread evenly among all licensees and all forms of tenure.

B.2 Economic Impact Analysis Methodology

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators, and processing facilities in the TSA. Other general economic data are from BC STATS, the B.C. Ministry of Finance and Corporate Relations, Statistics Canada, and local communities.

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is a full-time job that lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1) harvesting;
2) silviculture; and,
3) timber processing.

The procedure for estimating employment and income impacts involves several steps. First, current activity in each of the three sub-sectors was assessed. Then, indirect and induced employment and employment income impacts were estimated using data from the B.C. Ministry of Finance and Corporate Relations and Statistics Canada. Next, employment coefficients were calculated and applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes, were also calculated using B.C. Ministry of Forests stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands-related jobs including harvesting, log transport, log salvage, planning, and administration functions. While road building and maintenance work are important activities in the forest industry, the employment multipliers used in this analysis define these activities as indirect rather than direct. Therefore, road building and maintenance employment are not included in the direct impact estimates, but are captured in the estimates of indirect impacts. Including these as direct would double-count and overestimate employment impacts.

Data on employment, place of residence, and timber flows were obtained through a survey of licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of residents *versus* non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

1) TSA direct employment in harvesting consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and,
2) Provincial direct employment in harvesting consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting-related activities.

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients per 1000 cubic metres. These employment coefficients were then used to estimate harvesting employment associated with the different harvest levels in the base case forecast.

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilization, pruning, and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part-time during the year. Because of this, silviculture jobs were converted into equivalent full-time person-years of employment. Respondents were also asked to estimate the percentage of their silviculture employees who lived within the TSA and outside the TSA.

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment — timber processing

Information about employment, production, and sources of timber was gathered from TSA mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber requirement was supplied by the harvest from the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest.

Employment figures were also adjusted to reflect the residences of workers (i.e., those who lived within the TSA and those who lived outside the TSA). Employment in timber processing that is supported by chip by-products from milling operations was similarly estimated.

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates

Indirect employment in the forestry sector refers to those who provide goods and services to firms directly engaged in the basic forestry sector (for example, those who provide road maintenance services). Induced employment refers to those who provide the goods and services purchased by employees who are directly and indirectly engaged in the industry (for example, those who work in retail outlets). Indirect and induced employment figures were calculated using TSA and provincial employment multipliers developed by the B.C. Ministry of Finance and Corporate Relations.

Two sets of employment multipliers were used for this report: migration multipliers and no-migration multipliers. The migration multipliers assume that displaced workers will leave the region, reducing total income in the region by their full wage. The no-migration multipliers assume that a displaced worker remains in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the degree of induced impacts associated with a change in direct employment.

B.2 Economic Impact Analysis Methodology

The TSA and provincial employment multipliers used in the Invermere TSA analysis are as follows:

Table B-1. Employment multipliers — Invermere TSA

Forest sub-sector	TSA migration multiplier	TSA no-migration multiplier	Provincial (Interior) migration multiplier	Provincial (Interior) no-migration multiplier
Harvesting	1.34	1.23	2.14	1.80
Solid wood processing	1.40	1.27	2.29	1.93
Plywood	1.40	1.27	1.93	1.64
Pulp	1.63	1.49	3.02	2.48

Sources: Ministry of Finance and Corporate Relations. *The 1996 Forest District Tables*, April, 1999.

Ministry of Finance and Corporate Relations. *A Provincial Impact Estimation Procedure for the British Columbia Forest Sector*. 1996.

Estimates of employment income

Employment income was calculated using average income estimates for workers in the forest industry. Based on Statistics Canada data, the weighted average annual pre-tax income (less benefits) for forest sector workers in 1999 was:

$46,956 for those working in logging and forestry services;

$44,980 for those working in solid wood manufacturing; and,

$58,136 for those working in pulp and paper mills.

The average income was approximately $30,732 for those in indirect and induced occupations. Income taxes were calculated based on marginal tax rates of 23 to 28% with one third of the total income tax paid accruing to the province.

Employment estimates of alternate timber supply levels

To estimate employment generated by alternative timber supplies, the forecast harvest level is multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions in future years. Therefore, the employment estimates should be viewed as indicators of orders of magnitude of change rather than as precise estimates of changes in employment levels.

Provincial government revenues

Except for stumpage, royalty and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using industry averages. Revenues per 1000 cubic metres of harvest, expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the base case forecast in a manner similar to how employment impacts were estimated. See Table B-2.

B.2 Economic Impact Analysis Methodology

Table B-2. Estimates of provincial government revenues — Invermere TSA

(Base on 1997 – 1999 average annual harvest of 584 126 cubic metres)

	Average revenue 1997-1999 ($1999 millions)	Revenue per cubic metre of wood ($ / '000s m^3)
Stumpage and related payments[a]	10.157	17,388
Forest industry taxes[b]	4.538	7,769
Employee income tax[c]	4.297	7,356
Total government revenues	18.992	32,513

(a) Ministry of Forests, Revenue Branch.

(b) Based on estimates by PriceWaterhouseCoopers. Includes taxes for logging, corporate income, corporate capital, sales, property and electricity.

(c) Estimated from Revenue Canada income tax rates and includes only the provincial share of income taxes paid.